THE

Tea Research Institute

OF

Ceylon

Annual Report for the Year 1959

Published by
THE TEA RESEARCH INSTITUTE OF CEYLON
ST COOMBS, TALAWAKELE, CEYLON,
1960.

The Tea Research Institute of Ceylon

Staff at December 31st 1959

Director	D. L. Gunn, C.B.E., D.Sc. (Wales), Ph.D. (Birm.)
Agricultural Chemistry	
Agricultural Chemist ...	J. A. H. Tolhurst, B.Sc. (Reading)
Research Assistant ...	*Vacant*
Senior Technical Assistants	E. N. Perera
	V. Mendis
Assistants	S. Samarasingham
	T. C. Z. Jayman
	E. O. Steuart
Biochemistry	
Biochemist	*Vacant*
Research Assistant ...	M. S. Ramaswamy, B.Sc. (Mysore), A.R.I.C., A.I.I.Sc.
Assistants	T. S. Nathan
	B. P. M. Perera
Technology	
Technologist	E. L. Keegel
Research Assistant ...	D. Kirtisinghe, B.Sc. (Cey.)
Assistants	K. Sothisrihari
	L. S. Weragoda
Plant Physiology	
Plant Physiologist ...	T. Visser, Dr. Ir. (Wageningen)
Vegetative Propagation Officer	F. H. Kehl
Research Assistant ...	K. L. D. Ameratunga, M.Sc. (Mysore)
Senior Technical Assistant ...	M. Piyasena
Assistants	A. C. B. Pethiyagoda
	N. de S. Jayasundere
	S. Nagarajah, B.Sc. (Cey.)
	A. R. M. Hassim
	D. D. Kroon
	H. B. Ratnayake
	J. I. H. Bandaranayake
	H. R. Solomon
Plant Breeding	
Plant Breeder	*Vacant*
Plant Pathology	
Plant Pathologist	D. Mulder, Nat. Phil. Dr (Amsterdam)
Research Assistants ...	*N. Shanmuganathan, B.Sc. (Cey.)
	R. L. de Silva, B.Sc. (Cey.)
Assistants	W. Redlich, B.Sc. (Cey.)
	S. Murugiah
Entomology	
Entomologist	J. E. Cranham, B.A. (Cantab.), D.I.C.
Entomologist, Special Research	E. Judenko, Ph.D. (Cracow)
Research Assistant ...	*D. Calnaido, B.Sc. (Cey.)
Senior Technical Assistant ...	D. J. W. Ranaweera
Assistants	E. F. W. Fernando
	C. Shanmugam
	G. B. Rajapakse
Nematology	
Nematologist	M. T. Hutchinson, B.Sc., Ph.D. (Rutgers)
Research Assistant ...	R. A. Jayatilleke, B.Sc. (Cey.)
Assistants	M. K. Vythilingam
	P. A. John
Agronomy	
Chief Agronomist ...	*Vacant*
Low-Country Advisory Service	
Scientific Adviser	A. W. R. Joachim, O.B.E., B.Sc., Ph.D. (Lond.), F.R.I.C., Dip. Agric. (Cantab.)
Assistants	A. E. T. Ellawella
	U. L. M. de Silva

*Working overseas.

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THIRTY-FOURTH ANNUAL REPORT OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON FOR THE YEAR 1959

Foundation.—The Tea Research Institute of Ceylon was established by Ordinance No. 12 of 1925 dated 27th October, 1925.

The constitution of the Board of Control is laid down in the above Ordinance and in the following Tea Research (Amendment) Acts:—

No. 24 of 1948	dated	20th December, 1948
No. 32 of 1951	,,	1st September, 1951
No. 51 of 1953	,,	19th December, 1953
No. 20 of 1955	,,	14th April, 1955
No. 8 of 1957	,,	18th March, 1957
No. 2 of 1959	,,	21st January, 1959
No. 3 of 1959	,,	21st January, 1959

The members of the Board on 1st January, 1959 were:—

Chairman: Mr F. Amarasuriya.

Ex-Officio Members

The Director of Agriculture (Dr M. F. Chandraratna, M.B.E.).

The Hon'ble Minister of Finance (represented by Mr H. E. Peries, O.B.E., C.C.S.), Deputy Secretary to the Treasury.

The Chairman, Planters' Association of Ceylon (Mr H. Creighton).

The Chairman, Agency Section, Planters' Association of Ceylon (Mr P. W. Keun).

The Chairman, Low-Country Products Association of Ceylon (Mr C. Selwyn Samaraweera).

The Tea Controller (Mr B. Mahadeva, C.C.S.).

Representatives of the Planters' Association of Ceylon

Mr R. C. Scott, C.B.E.
Mr N. M. Sanders
Mr W. H. W. Coultas

Representatives of the Planters' Association of Ceylon, Agency Section

Mr G. K. Newton
Mr R. D. Wedd
Mr R. J. Gilmour

Representatives of the Low-Country Products Association

Mr F. Amarasuriya
Mr J. L. D. Peiris
Mr Errol Jayawickreme

Representatives of the Smallholders

Mr D. E. Hettiarachchi
Mr Reginald Perera

Representatives of the House of Representatives

Mr S. Jinadasa, M.P.

Secretary: Mr G. A. D. Kehl
Solicitors: Messrs Julius & Creasy.
Auditors: Messrs Ford, Rhodes, Thornton & Co.
Registered Office: St Coombs, Talawakele.

The following changes in the personnel of the Board were recorded during the year:—

Ex-Officio members:—1. The Director (Dr A. W. R. Joachim, O.B.E.) became an ex-officio member of the Board with effect from 21st January.

2. Mr D. G. L. Misso, C.C.S., Acting Deputy Secretary to the Treasury vice Mr H. E. Peries, O.B.E., C.C.S., on leave with effect from 2nd April to 22nd June.

3. Mr G. I. de Glanville, Chairman of the Agency Section, Planters' Association of Ceylon, vice Mr P. W. Keun, with effect from 18th April.

4. Mr C. D. Green, Chairman, Agency Section, Planters' Association. vice Mr G. I. de Glanville from 22nd July to 7th October.

5. Dr D. L. Gunn, C.B.E., (Director, T.R.I.) vice Dr A. W. R. Joachim, O.B.E., with effect from 1st October.

Representatives of the Planters' Association of Ceylon:—Mr W. H. W. Coultas was re-nominated for a further period of 3 years with effect from 14th February.

Mr J. N. Atkinson acted for Mr N. M. Sanders from 24th April to 2nd July.

Mr R. C. P. Adams acted for Mr R. C. Scott, C.B.E., from 24th April to 4th December.

Representatives of the Agency Section, Planters' Association of Ceylon:—Mr R. M. Macintyre acted for Mr R. D. Wedd from 2nd April to 31st July.

Mr R. D. Wedd resumed his seat with effect from 14th October.

Mr R. M. Macintyre vice Mr G. K. Newton (resigned) with effect from 1st August.

Mr A. D. McLeod acted for Mr R. J. Gilmour from 25th June to 4th October.

Representatives of the House of Representatives.—Mr S. Jinadasa, M.P., was re-nominated for a further period of 3 years with effect from 1st January.

Secretary to the Board.—Mr H. J. Balmond took over the Secretaryship of the Board from Mr G. A. D. Kehl with effect from 1st July.

Five meetings of the Board were held during the year on 6th March, 10th April, 5th June, 4th September and 4th December.

Administrative Committee.—The Chairman, T.R.I. (Mr F. Amarasuriya), Messrs B. Mahadeva, C.C.S. (Tea Controller), R. D. Wedd, C. Selwyn Samaraweera, R. J. Gilmour, W. H. W. Coultas, J. L. D. Peiris, The Director (Dr A. W. R. Joachim, O.B.E.) and Mr G. A. D. Kehl (Secretary).

The following changes in the membership of the Committee took place during the year:—

Mr W. H. W. Coultas was re-appointed with effect from 14th February.

Mr R. M. Macintyre acted for Mr R. D. Wedd from 1st April to 14th October.

Mr A. D. McLeod acted for Mr R. J. Gilmour from 25th June to 4th October.

Dr D. L. Gunn, C.B.E., as Director vice Dr A. W. R. Joachim, O.B.E., with effect from 1st October.

Mr H. J. Balmond as Secretary vice Mr G. A. D. Kehl as from 1st July.

Ten meetings of the Committee were held on 6th January, 21st February, 6th March, 25th April, 23rd May, 18th June, 31st July, 15th August, 16th October and 21st November.

Experimental and Estate Committee.—Chairman, The Director, T.R.I. (Dr A. W. R. Joachim, O.B.E.), Mr F. Amarasuriya (Chairman, T.R.I.), The Visiting Agent, St Coombs Estate (Mr G. K. Newton), The Superintendent, St Coombs Estate (Mr T. B. Pethiyagoda), The Chairman, Planters' Association of Ceylon (Mr H. Creighton), The Chairman, Agency Section, Planters' Association of Ceylon (Mr P. W. Keun), Messrs R. C. Scott, C.B.E., D. E. Hettiarachchi, J.P., U.M., S. P. Vytilingam, R. C. P. Adams, R. L. Harvey, J. E. Davidson, A. Watt, C. M. G. Moberley, E. N. Whitefield, R. J. S. Bean, A. J. Pelly-Fry, the Senior Staff of the Institute, the Vegetative Propagation Officer and the Research Assistant to the Biochemist; Mr E. L. Keegel acted as Convener/Secretary.

The following changes in membership of the Experimental and Estate Committee were recorded during the year:—

Mr B. D. Fay acting for Mr R. L. Harvey from 7th May to 6th October.

Mr H. D. Ross acting for Mr E. N. Whitfield from 6th April to 5th October.

Mr G. I. de Glanville, Chairman, Agency Section of the Planters' Association of Ceylon vice Mr P. W. Keun with effect from 18th April.

Mr C. D. Green, Chairman, Agency Section of the Planters' Association of Ceylon vice Mr G. I. de Glanville from 22nd July to 7th October.

Mr W. H. W. Coultas was appointed to the Committee as representative of the Administrative Committee with effect from 4th September.

Mr A. L. Elias, Superintendent, St Coombs vice Mr T. B. Pethiyagoda with effect from 15th September.

Dr D. L. Gunn, C.B.E., Director from 1st October.

Mr Alexander Mackie, Visiting Agent, St Coombs Estate, vice Mr G. K. Newton from 10th October.

Mr R. J. S. Bean was on two months leave as from 16th October.

Mr A. E. A. Wallace-Tarry vice Mr R. C. P. Adams resigned 31st December.

Mr P. S. Gray vice Mr C. M. G. Moberley resigned 31st December.

Appointments Committee.—The Chairman (Mr F. Amarasuriya), Messrs B. Mahadeva, C.C.S., Dr M. F. Chandraratna, M.B.E., N. M. Sanders, G. K. Newton, The Director, T.R.I. (Dr A. W. R. Joachim, O.B.E.) and Mr G. A. D. Kehl (Secretary); Dr E. D. C. Baptiste, Director, Rubber Research Institute, to be co-opted for Senior Staff appointments.

The following changes took place during the year:—

Mr W. H. W. Coultas acted for Mr N. M. Sanders from 24th April to 2nd July.

Mr C. D. Green vice Mr G. K. Newton (resigned) with effect from 1st August.

Mr G. I. de Glanville vice Mr C. D. Green with effect from 7th October.

Dr D. L. Gunn, C.B.E. vice Dr A. W. R. Joachim, O.B.E., with effect from 1st October.

Mr H. J. Balmond as Secretary vice Mr G. A. D. Kehl with effect from 1st July.

Eight meetings of the Committee were held during the year on 6th January, 21st February, 7th May, 23rd May, 5th June, 11th July, 18th July and 18th September.

Low-Country Committee.—The Chairman (Mr F. Amarasuriya), Messrs J. L. D. Peiris, G. K. Newton, H. Creighton, R. J. S. Bean, A. Watt, the Director (Dr A. W. R. Joachim, O.B.E.) (Convener).

Dr D. L. Gunn became a member of the committee with effect from 1st October.

Mr Errol Jayawickreme vice Mr G. K. Newton with effect from 1st August.

Four meetings of the Committee were held during the year on 26th June, 11th August, 3rd September and 14th September.

Building Committee.—Mr F. Amarasuriya (Chairman), Mr W. H. W. Coultas (Vice-Chairman), Mr J. L. D. Peiris, the Director, T.R.I. (Dr A. W. R. Joachim, O.B.E.) and Mr G. A. D. Kehl (Secretary).

The following changes took place during the year:—

Dr D. L. Gunn, C.B.E. vice Dr A. W. R. Joachim, O.B.E., with effect from 1st October.

Mr H. J. Balmond vice Mr G. A. D. Kehl with effect from 1st July.

Trustees of the Tea Research Institute of Ceylon Junior Staff Provident Fund.—The Chairman, T.R.I. (Mr F. Amarasuriya), The Director, T.R.I. (Dr A. W. R. Joachim, O.B.E.), Messrs D. E. Hettiarachchi, J.P., U.M., R. J. Gilmour and E. N. Perera (representative of the Junior Staff).

Dr D. L. Gunn, C.B.E., succeeded Dr A. W. R. Joachim, O.B.E., with effect from 1st October.

A vacancy was created with effect from 21st December when Mr E. N. Perera left St. Coombs.

Committee of Management, Tea Research Institute of Ceylon Junior Staff Medical Fund.—The Chairman, T.R.I. (Mr F. Amarasuriya), The Director, T.R.I., Mr G. D. Austin representing the Junior Staff.

Mr Austin left the service of the Institute on 31st August.

Visiting Agent.—Mr G. K. Newton continued to act as Visiting Agent for St. Coombs Estate until 31st July.

Mr Alexander Mackie was appointed to succeed Mr G. K. Newton and took up duties on his return to the Island from leave on 10th October.

Finance.—Income for the year totalled Rs. 2,471,988 and was less by Rs. 277,445 than that for the previous year, chiefly due to reductions of Rs. 162,751 in the profit from St Coombs Estate and of Rs. 147,621 from the Cess. The exporters, after paying taxes, paid an average of 42 cents per pound less for St Coombs tea; the Estate, after paying all dues, received the same amount less per pound, resulting in a reduction of Rs. 111,224 on price and a reduction of Rs. 126,561 on a crop sold that was lower by 42,187 lb. Savings on working and changes in miscellaneous receipts reduced the total of these two reductions to a net reduction of Rs. 162,751, as given. Other sources of income, *viz.* Interest Rs. 82,901, Tea Subsidy Fund Rs. 11,500, Rent of Caddy Rs. 1,800 and other miscellaneous receipts Rs. 10,937, totalled Rs. 107,138 as against Rs. 74,210 in 1958.

Revenue expenditure (excluding depreciation) amounted to Rs. 1,988,907 as against Rs. 1,642,552 in the previous year. Once again the increase was mainly due to success in recruitments to the staff, the total increase on staff being Rs. 290,538 including Provident Fund payments.

Capital expenditure remained about the same, being Rs. 480,138 as against Rs. 490,050 in 1958. Main heads of expenditure were: buildings Rs. 210,959; vehicles Rs. 74,623; furniture and equipment Rs. 68,649; land development Rs. 59,186, and laboratory equipment Rs. 43,163.

Accumulated depreciation as at 31st December, 1959, was Rs. 1,820,175, with Liquid Assets amounting to Rs. 3,833,296 and Liabilities amounting to Rs. 303,567. Capital expenditure already under contract and contemplated during 1960 and 1961 is calculated to absorb the whole of the Institute's reserves and make it necessary to ask for an increase in cess.

Acknowledgements.—The Board records its thanks to the Ceylon Association in London, the Planters' Association of Ceylon, the Agency Section of the Planters' Association of Ceylon, the Low-Country Products Association and other institutions for their continued support and co-operation in matters concerning the Institute and the Tea Industry in Ceylon.

The Board also extends its thanks to the Planters' Association of Ceylon, the Tea Controller, and the Director of the Ceylon Institute of Scientific and Industrial Research, for having placed their meeting rooms at its disposal.

Auditors.—Messrs Ford, Rhodes, Thornton & Co., continued to act as the Institute's Auditors. The Audited Statement of Accounts and the Balance Sheet for the year ending 31st December, 1959, are attached to this report.

H. J. BALMOND
Secretary.

BALANCE SHEET AS AT 31st DECEMBER, 1959.

1958 Rs.			Rs.	1959 Rs.	1958 Rs.		Rs.	Rs.	1959 Rs.
	ACCUMULATED FUND					FIXED ASSETS:—			
	Expended on Fixed Assets:					Cost	5,420,749		
	Balance at 31st December, 1958		5,420,749			Additions during the year	480,137		
	Additions less disposals		451,300				5,900,886		
				5,872,049		*Less:* Sales, scrap and transfers during the year at cost	28,887		
	Unexpended Fund.				5,420,749			5,872,049	
	Balance at 31st December, 1958		1,427,257			Depreciation to 31st December, 1958	1,586,946		
	Add: Adjustment during the year		506,111			Depreciation written off during the year ..	255,594		
			1,933,368				1,842,540		
	Less: Additions to Fixed Assets less disposals during the year ...		451,301		1,586,946	*Less:* Depreciation on sales and scraps during the year ...	22,365	1,820,175	
			1,482,067		4,833,803				4,051,874
	Add Excess of income over expenditure .		227,487	1,709,554	—				
6,848,006				7,581,603		INVESTMENTS AT MARKET VALUE			
						Ceylon Government Securities		858,725	
						United Kingdom Government Securities		45,181	
207,644	CREDITORS AND PROVISIONS			207,081	962,124				903,906
39,464	PROVISION FOR FURLOUGH PAY AND PASSAGE			96,486		CURRENT ASSETS :—			
						Debtors—General		199,044	
511,880	SMALL HOLDINGS ADVISORY SERVICE			—		Debtors and other debit balances—Research .		74,469	
						Debtors—Staff		111,763	
						Stocks		134,918	
						Cash in hand and at bank		2,409,196	
					2,810,568				2,929,390
7,606,494			Rs.	7,885,170	7,606,494			Rs.	7,885,170

We have examined the above balance sheet with the books of the Tea Research Institute of Ceylon and St. Coombs Estate and have obtained all the information and explanations we have required. In our opinion the foregoing balance sheet is properly drawn up so as to exhibit a true and correct view of the financial affairs of the Institute as at 31st December, 1959, according to the best of our information and the explanations given to us and as shown by the books.

Colombo, 21st June, 1960.

(*Signed*) FORD, RHODES, THORNTON & Co.,
Chartered Accountants.

THE TEA RESEARCH INSTITUTE OF CEYLON.

ESTATE WORKING ACCOUNT FOR THE YEAR ENDED 31st DECEMBER, 1959

1958 Rs.			Rs.	1959 Rs.	1958 Rs.		lbs.	Rs.	1959 Rs.
		ESTATE EXPENDITURE:—				TEA SALES—GROSS PROCEEDS:—			
	117,722	General charges	114,829		935,016	Colombo	661,818	764,629	
	81,229	Upkeep	78,340		9,015	Local—on Estate	2,489	12,188	
	91,955	Cultivation	89,841		904	Brochemical Department	588	1,401	
	117,206	Harvesting	117,857			Gratis	2,360		
188,542	110,429	Manufacture	108,243	467,819					
					944,935		280,150		778,218
14,935		Colombo Storage and handling charges		11,779					
25,815		Boarding Staff			99	Profit on sale of firewood			
		Sales Tax		70,325		Sale of clonal cuttings			27,249
		Debit Tax on Sales Tax		71					
418,724		Balance to Income and Expenditure Account		255,973					
915,044				805,467	915,044			Rs.	805,467

THE TEA RESEARCH INSTITUTE OF CEYLON.

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER, 1959

1958 Rs		Rs.	1958 Rs.		Rs.
163,249	Administration	186,808	418,724	Balance from Estate Working Account	235,973
[illegible]	Senior Scientific Staff	[illegible]	2,256,488	Tea Cess	2,108,877
[illegible]	Intermediate Scientific Staff	76,397	72,234	Interest	82,901
[illegible]	Junior Scientific Staff and Manual Employees	[illegible]	1,800	Rent of kadday	1,800
42,342	Laboratory ...	54,534	177	Miscellaneous receipts	1,089
20,984	Library and Publication	39,976		Tea replanting subsidy ..	11,500
[illegible]	Field and factory experiments	2[illegible]	-	Profit on sale of investment	2,250
85,151	Travelling of Staff	92,184	—	Profit on sale of Fixed Assets ...	7,588
45,907	Engineering Department	44,566			
81,008	Maintenance of Buildings	41,904			
126,421	General Services	148,139			
35,953	Miscellaneous	41,730			
350,000	Small Holding Advisory Service	350,000			
28,212	Replanting Expenditure				
211,802	Depreciation	255,594			
442	Depreciation of Investments ...	10,467			
1,275	Loss on stone crusher working				
836	Loss on sale of Fixed Assets				
—	Junior Staff Provident Fund ..	73,284			
895,079	Balance of Income over Expenditure	227,187			
2,749,433		Rs. [illegible]	2,749,433		Rs. 2,471,988

THE TEA RESEARCH INSTITUTE OF CEYLON.

SUMMARY OF FIXED ASSETS AND VEHICLES—31st DECEMBER, 1959

	ASSET ACCOUNT				DEPRECIATION ACCOUNT				
	Cost at 31-12-58	Additions 1959	Sales Transfers and Scrap 1959	Cost at 31-12-58	Accumulated at 31-12-58	For the Year	On Sales and Scrap	Accumulated at 31-12-59	Written down value at 31-12-59
	Rs. cts.	Rs. cts.	Rs. cts.	Rs. cts.	Rs. cts.	Rs. cts.	Rs. cts.	Rs. cts.	Rs. cts.
Land including Development	1,396,526.66	59,186.35	—	1,455,713.01	104,995.25	27,408.17	—	132,403.42	1,323,309.59
Buildings and Lines	2,693,592.09	185,959.07	—	2,879,551.16	872,063.20	79,367.43	—	951,430.63	1,928,120.53
Furniture and Equipment	438,490.84	68,649.09	—	507,139.93	141,501.13	43,171.38	—	184,672.51	322,467.42
,, Board of Survey	80,714.08	—	—	80,714.08	16,093.01	8,071.40	—	24,164.41	56,549.67
Laboratory Equipment	201,923.39	43,163.42	—	245,086.81	90,657.31	15,978.68	—	106,635.99	138,450.82
Experimental Machinery	77,812.55	706.26	—	78,518.81	61,453.24	7,781.25	—	69,234.49	9,284.32
Estate Machinery	192,043.12	17,696.25	—	208,739.37	159,184.00	19,204.31	—	178,388.31	31,351.06
Workshop Machinery	27,191.24	—	—	27,191.24	8,371.49	2,719.12	—	11,090.61	16,100.63
,, Equipment	16,019.46	2,569.63	—	18,589.09	5,242.20	1,601.94	—	7,844.14	10,744.95
,, Furniture	3,627.55	175.00	—	3,802.55	719.50	362.75	—	1,082.25	2,720.30
Vehicles—Institute	130,777.03	74,022.31	25,888.75	179,510.79	56,061.39	26,222.01	19,113.71	62,869.89	116,640.90
,, —Workshop	53,773.01	200.50	2,948.10	51,025.41	28,483.33	10,725.75	2,948.10	36,260.98	14,764.43
Library Shelving	2,391.78	—	—	2,391.78	478.34	239.17	—	717.51	1,674.27
Spectrophotometer	16,165.68	—	—	16,165.68	4,076.82	1,616.56	—	5,693.38	10,472.30
Leaf Heat	2,055.38	—	—	2,055.38	2,055.38	—	—	2,055.38	—
Lawn Mowers	767.78	—	—	767.78	632.08	76.77	—	708.85	58.93
Monkey Grubber	2,534.77	—	—	2,534.77	2,027.76	253.47	—	2,281.23	253.54
Dusters, Sprayers and Pumps ...	20,923.68	—	—	20,923.68	10,420.72	2,092.36	—	12,513.08	8,410.60
Leaf Elevator ...	10,708.55	—	—	10,708.55	4,283.40	1,070.85	—	5,354.25	5,354.30
Winget Stone Crusher	15,733.80	—	—	15,733.80	11,800.35	3,933.45	—	15,733.80	—
Vegetative Propagation Expansion—Capital	36,976.00	2,209.55	—	39,185.55	5,342.69	3,697.60	—	9,040.29	30,145.26
Building in Progress	—	25,000.00	—	25,000.00	—	—	—	—	25,000.00
Rs.	5,420,718.44	480,137.63	28,836.85	5,872,049.22	Rs. 1,586,945.59	255,594.45	22,764.64	1,820,175.40	4,051,873.82

REPORT OF THE DIRECTOR FOR 1959

D. L. Gunn, C.B.E., D.Sc.

During 1959, the Director, Dr A. W. R. Joachim, O.B.E., began to implement the recommendations of the Co-ordinating Sub-Committee of the Board of the Institute for the expansion of the Institute's activities (Annu. Rep. for 1957, page 24). Additions to the senior staff included Mr J. E. Cranham from Ghana who took charge in entomology, Dr M. T. Hutchinson (nematology), who was provided by the United States Operations Mission, and Mr H. J. Balmond, who left his post as Registrar of the University to become Chief Administrative Officer. A new Advisory Division was set up, to take the heavy load of advisory work off the research men, and Mr C. B. Foster-Barham from the Tea Research Institute at Kericho, Kenya, took charge of it in November. I arrived from Central Africa in October and enabled Dr Joachim to revert to his main interest in the low country. By the end of the year, arrangements were being made to obtain several additional senior officers. Mr A. L. Elias replaced Mr T. B. Pethiyagoda as Estate Superintendent in October. The scheme for further training overseas of Ceylonese officers was begun, with Mr D. Calnaido (Rothamsted, U.K.), Mr N. Shanmuganathan (East Malling, U.K.), and Mr J. V. Sabanayagam (Ontario Agricultural College, Guelph, Canada). As the appended list shows, during the year the senior staff gained 5 and lost 2 members, intermediate gained 1 and lost 1, and the junior staff gained 11 and lost 1, a net increase of 13 in these grades.

By the end of the year, the three new senior-staff houses were occupied, all guest-house accommodation was in use for members of the staff, several houses were over crowded, and some officers had to live at Nuwara Eliya and elsewhere outside the estate. Some improvements were made to the laboratory but it became clear that it was urgently necessary to push the main building scheme through. Contracts were signed for building more senior, intermediate, and junior staff houses and for a filter system for the water supply. Reserve funds were available for this, but the expansion of work had already caused them to be dipped into for recurrent expenditure. An agreed increase in the cess from 55 to 75 cents per 100 lb. of tea exported could not be made at the end of the year, because Parliament had been dissolved, and it was evident that a larger increase would be required to carry out the recommendations of the Co-ordinating Sub-Committee.

The outstanding event of the year has been the inauguration of the Tea Replanting Subsidy Scheme, by which an export cess of 400 cents per 100 lb. of tea exported is to be drawn upon for subsidies for planting or replanting in high-yielding varieties of vegetatively-propagated tea (clones). Vegetative propagation was begun by Dr F. R. Tubbs at the Institute more than twenty years ago and some of the clones then selected by him have been the most popular ones in the Subsidy Scheme. The Institute is carrying on the work very actively. At the end of 1959, clones were being tested for various properties at several altitudes and arrangements were being made for additional clonal-testing stations, both on estates and on land to be acquired by the

Institute. Unfortunately negotiations to buy a particular low-country estate as a T.R.I. Low-country Sub-station fell through early in 1960 and a search was renewed for suitable land.

The investigations into the manufacture of a powder tea, made by the Ceylon Institute for Scientific and Industrial Research under Dr A. Sundralingam in collaboration with senior officers of the T.R.I., have been successful in producing from fresh mid-country leaf a product not inferior to those already on the market. At the end of the year, a pilot plant was being put together at C.I.S.I.R. for installation at T.R.I. with a view to enlargement in two stages to commercial size.

Towards the end of the year, a Scientific Advisory Committee in the United Kingdom (SACUK) was set up, with effect from 1st January, 1960, having Dr F. R. Tubbs as Chairman and Convener. Professor G. E. Blackman, F.R.S. (Sibthorpian Professor of Rural Economy at Oxford), Mr F. C. Bawden, F.R.S. (Director of Rothamsted Experimental Station), and Professor T. A. Bennet-Clark, F.R.S., (Professor of Botany, King's College, London) agreed to be members of it, the Ceylon Association in London was to send an observer, and two seats remained to be filled.

It will have been noticed that the Annual Report for 1958 was designated in that way and not as a numbered bulletin; that change is now established. A new series of Bulletin was begun in 1959 with No. 1 on "The Propagation of Tea Cuttings", by Dr Visser and collaborators. The Tea Quarterly came out in three parts, the June and September numbers being combined. Mr Keegel's second edition of Monograph No. 4 on manufacture was dated 1958 but actually appeared in 1959.

The reports that follow, on St Coombs Estate, the advisory work, and the research work of the various Divisions, give detailed accounts of the work of the year.

STAFF CHANGES

Appointments

Director

Dr D. L. Gunn arrived in the Island on 1st October and succeeded Dr A. W. R. Joachim as Director on 5th October.

Senior Staff

Dr A. W. R. Joachim, on relinquishing his duties as Director, became Low-country Scientific Adviser again as from 9th October.

Dr Mulder acted for Dr Visser during his absence on leave from 21st April to 24th July.

Mr J. E. Cranham — Entomologist from 16th January and assumed duties in the Island on 22nd April.

Mr H. J. Balmond — Chief Administrative Officer from 1st July.

Dr M. T. Hutchinson — Nematologist from 26th August, when Dr Visser handed over to him.

Mr A. L. Elias — Superintendent, St Coombs, from 15th September.

Mr C. B. Foster-Barham — Chief Advisory Officer from 15th November.

Intermediate Staff

Mr R. A. Jayatilleke — Research Assistant to the Nematologist, from 1st June.

Junior Staff

Mr A. E. T. Ellawella — Technical Assistant to the Low-country Scientific Adviser, from 1st January.

Mr W. Redlich — Technical Assistant to the Plant Pathologist, from 7th January.

Mr J. B. A. Wickremasinghe — Technical Assistant to the Technologist, from 1st February.

Mr S. Nagarajah — Technical Assistant to the Plant Physiologist, from 1st February.

Mr G. A. S. Gunasinghe — Stenographer, from 1st March.

Mr W. J. Samuel — Accounts Clerk, from 1st May.

Mr E. O. Steuart — Technical Assistant to the Agricultural Chemist, from 18th May.

Mr T. C. Z. Jayman — Technical Assistant to the Agricultural Chemist, from 6th July.

Mr L. S. Weragoda — Technical Assistant to the Low-country Scientific Adviser, from 1st August.

Mr U. L. M. de Silva — Technical Assistant to the Low-country Scientific Adviser, from 25th September.

Mr A. R. M. Hassim — Technical Assistant to the Plant Physiologist, from 11th December.

Transfers

Mr T. S. Nathan from Agricultural Chemistry Division to Biochemistry Division from 1st January.

Mr M. K. Vythilingam from Plant Pathology Division to Nematology Division from 26th August.

Mr P. A. John from Plant Pathology Division to Nematology Division from 26th August.

Mr J. V. Sabanayagam from Plant Pathology Division to Advisory Division (St Coombs) from 15th November.

Mr L. M. de W. Tillekeratne from Plant Physiology Division to Advisory Division (St Coombs) from 15th November.

Overseas Training

Mr D. Calnaido, Research Assistant to the Entomologist, left on 15th April for post-graduate studies at Rothamsted Experimental Station, U.K.

Mr N. Shanmuganathan, Research Assistant to the Plant Pathologist, left on 19th May for post-graduate studies at the East Malling Research Station, U.K.

Mr J. V. Sabanayagam, Technical Assistant, left for Canada on a Colombo Plan Scholarship on 11th July.

Resignations

Mr J. B. A. Wickremasinghe, Technical Assistant, on 1st June (Junior Staff).

Mr M. Selvaratnam, Research Assistant to the Agricultural Chemist, on 1st June (Intermediate Staff).

Mr T. B. Pethiyagoda, Superintendent, St Coombs, on 31st September.

Retirements

Mr G. D. Austin, Entomologist, on 31st August (Senior Staff).

REPORT OF THE SUPERINTENDENT ON ST COOMBS ESTATE FOR 1959

A. L. Elias

Staff.—Following the departure of Mr T. B. Pethiyagoda at the end of September, I assumed duties as Superintendent of St Coombs on 1st October, 1959. I arrived on St. Coombs on the 15th of September and worked with Mr Pethiyagoda until the latter's departure on 30th September.

A qualified and registered midwife was engaged in September, the previous midwife leaving of her own accord.

Mr M. Ponnusamy, the Conductor, retired from service in June and was replaced by the Assistant K.P., Mr S. T. Ponnusamy, who assumed duties in the capacity of Head K.P. A plucking K.P., Mr P. Veloo, was engaged in July.

All other appointments remained unaltered.

Acreage at 31st December, 1959.—

	A.	R.	P.
Tea in full bearing	260	2	00
New clearing	18	1	00
Guatemala grass clearing	12	0	00
Land suitable for planting	7	3	11
Fuel clearings, etc.	36	3	12
Buildings, roads, gardens, etc. ...	50	2	14
Landing unsuitable for planting ...	38	0	00
	423	3	37

During the year tea was uprooted on about 5 acres in Field No. 8 for experimental purposes, and a further ¾ acre in Field No. 3 to make room for the new water-filtration plant.

In view of the many changes effected on St Coombs in recent years, acreage figures are not entirely certain and a re-survey of the estate is to be made in 1960.

Weather.—(Estate gauge).—

	Rainfall inches	Wet days	Sunshine hours
Registered in 1959 ...	92.90	212	1,996
Registered in 1958 ...	80.08	229	1,842
Registered in 1957 ...	97.72	221	1,992
Decennial averages (1949-1958) ...	89.93	229	1,821

Rainfall recorded in the first three months of the year was 5.60″, *i.e.* January—2.20″, February—2.20″, and March—1.20″. The fall in March was the lowest on record and very dry conditions prevailed during this period. In April, 8.34″ fell in the first half of the month, but the 10.34″ in May was evenly spread out. Severe monsoon conditions existed throughout June (19.51″), July (15.48″), and August (7.30″) and the south-west winds were particularly strong during July, tailing off towards the end of the month. Rainfall from September to December was fairly evenly distributed; inter-monsoonal showers started on 9th October and continued throughout the month. In November and December, evenly distributed north-east showers fell and heavy mist was seen to settle in low-lying areas and hollows. The total fall of 92.80″ for the year was only slightly above the decennial average. No frost was experienced during the year. There were 212 wet days.

Crop.—

	1959	1958	1957
	lb.	lb.	lb.
Estimate	270,000	270,000	270,000
Total crop (including off grades)	280,150	320,080	286,171
Yield per acre on 260½ acres ...	1,060	—	—
Yield per acre on 265¾ acres ...	—	1,204	—
Yield per acre on 264¾ acres ...	—	—	1,074

The estimated crop of 270,000 lb. of made tea was exceeded by 10,150 lb. and the yield per acre for the year was 1,060 lb. The 1958 crop figure of 320,080 lb. with a yield of 1,204 lb. per acre constituted a record for St Coombs. The previous best yield of 298,763 lb. was obtained in 1955 with a yield of 1,104 lb. per acre.

February (19,490 lb.), March (14,236 lb.), April (16,125 lb.) and July (13,574 lb.) were poor cropping months but the final result can be considered extremely satisfactory in view of the drought conditions that prevailed during the early part of the year. In May, a record crop was harvested (54,118 lb.) and cash plucking and Sunday work had to be resorted to. The quality of leaf brought into the factory was good throughout and all teas continued to fetch good prices.

Prices and Total Crop Sold.—

Year	Total crop sold	Total price	Nett price
	lb.	cents	cents
1959	277,790	281	250
1958	317,956	297	293
1957	283,694	294	290

Prices fetched for St Coombs teas were high compared with the high-grown average and with those of neighbouring estates, and were often very near the top of the Colombo market. The nett sale average, however, has fallen considerably below those of the previous two years. The chief reason is the very poor prices realised for teas sold in July and August. The high-grown nett-sale average for the period 1st January to 21st December was Rs. 2.13.

The best invoices were:—

Invoice No.	Month	Rs. per lb.
1	January	4.60
5	February	4.90
6	February	4.61

Cost of Production.—

	1959 Cost per lb. cents	1958 Cost per lb. cents	1957 Cost per lb. cents
Estimate	180	175	168
Actual	167	153	162

Profit on Estate Working.—

1959	...	Rs. 255,973
1958	...	„ 418,724
1957	...	„ 345,956

Capital Expenditure.—

1959	...	Rs. 140,823	50 cents per lb.
1958	...	„ 152,854	48 „ „ „
1957	...	„ 183,535	64 „ „ „

The main items of capital expenditure were:—

	Rs.
Water service to lines	3,600
Waterborne sanitation to lines ...	4,366
New nursery	2,482
Buildings	43,874
New clearing	37,943
Ravines to be cleared	3,845
Opening up 4 acres in Guatemala grass ...	3,042
Factory	9,831
Furniture	4,377
New Ferguson tractor	9,767
Machinery	17,696

Plucking.—7–8 day rounds were maintained throughout the year and the standard of leaf harvested was of a fairly high quality. The plucking-incentive system of fixing a datum each day for each field has continued to prove satisfactory, though it did not completely eliminate the need for cash plucking after normal hours in the rush months nor the need to pluck on Sundays. The average per plucker for the year was 25 lb. compared with 28 lb. in 1958 and 26 lb. in 1957.

Estate Roads and Paths.—The usual routine maintenance of field roads, footpaths, and estate roads were carried out. Some terracing of side drains was done where necessary and silt pits were cut in steep areas. A motorable road was cut through Field No. 4, by enlarging an existing field road, to enable the tractor to transport spraying equipment to this hitherto inaccessible field. An existing field road through the gum clearing leading to the green manure nursery and to the V.P. nursery was widened and is now motorable.

Fuel Clearings.—Very little maintenance work was done during the year. Some drains in marshy areas were deepened and a few gums supplied. Part of the gum clearing (approximately 1 acre adjoining Field No. 14A) was uprooted and this area has been chosen for the new V.P. nursery on St Coombs. Firewood is plentiful and the immediate demands of all Institute staff can be met.

Ravines and Boundaries.—All boundaries have been clearly demarcated with drains and most of this work was carried out during the first three months of the year. Regular checks for weeds and cootch were maintained and all boundaries are in good order.

Many ravines were reclaimed during the year, and after necessary building up with masonry, were either planted up with clonal tea plants, where the soil was suitable, or with Guatemala grass, where soils tended to be waterlogged.

Weeding.—The cost of weeding for the year was Rs. 10.87 per acre per mensem against an estimated cost of Rs. 12.05. Weeding contracts continued to be popular. Except for prolific weed growth during May, June and July, favourable conditions prevailed during the rest of the year and weeds presented no real problem. Weeds were burned during the first half of the year, but this practice was discontinued and all weeds are now transported to central compost sheds and turned into compost by the Indore method.

A regular monthly round was completed, 195 acres being regularly weeded on contract and the remainder on estate account.

Pests and Diseases.—**Blister Blight.**—Spraying against Blister Blight began in mid-May and was continued until the end of the year. There were no serious large-scale attacks of blister in any of the fields, although localized attacks of some severity were noticed in certain susceptible areas. These areas were demarcated and received special attention. Pruned fields continued to be sprayed with single nozzles and careful attention was paid during the time of recovery from pruning. On the whole, the incidence of Blister Blight on the estate was slight. Field No. 12 was sprayed according to sunshine records in consultation with the Pathology Division.

Scarlet and Yellow Mites.—Attacks by Scarlet Mite and Yellow Mite were again noticed with the arrival of the dry weather. A number of heavily infested patches were selected and sprayed with the co-operation of the Entomology Division. The following areas were affected: Field No. 5—2 acres; the whole of Field No. 6—9½ acres; Field No. 9—7 acres; and Field No. 12—2 acres. These areas were sprayed with *Spersul* at a concentration of 1 lb. *Spersul* in 25 gal. of water and an application rate of 100 gal. per acre, sprayed twice within a fortnight, the areas being rested from plucking for three weeks. Generally the mite attack was considerably reduced by the early part of May. Towards the end of the year it was noticed that Field No. 13 had suffered from Scarlet Mite attack rather severely in certain areas; since this field is due to be pruned in 1960, resting of individual bushes was immediately done.

Pruning.—The following fields were pruned during the months indicated against each field:—

No. 1 — 2 acres, blocks 41 (TRI 2024) and 60 (TRI 2025)—May
No. 4 — 31¾ acres mid-April
No. 9 — 21⅕ acres—June-July
No. 10 — 12¾ acres—June
No. 10 — 2½ acres (1954 planting)—end of April.

A clean prune was adopted, taking out knotted and whippy branches. All pruning and tipping were done on the slope and recovery generally was good. Pruning commenced in mid-April after a few heavy showers had fallen. The 1954 clonal planting area of 2½ acres in Field No. 10 was pruned at the end of April so that clonal cuttings would be available in July/August. Blocks 41 and 60 in Field No. 1 (clones TRI 2024 and TRI 2025 (2 acres)) were pruned in May at 18" above ground level, the knife being used for the first time. A large portion of Field No. 9 was affected by frost during recovery from pruning in 1956, necessitating a secondary pruning back of dead wood. This operation has induced excellent new wood growth from below and new frames have been formed with very little wood-rot. In the case of Field No. 4, recovery was a little uneven.

Supplying and Nurseries.—Seedling plants in No. 1 nursery were attacked by thrips and by Yellow Mite and spraying was carried out with the co-operation of the Entomology Division.

Routine examination of V.P. plants by the Nematology Division in No. 1 and No. 12 nurseries has shown most of these plants to be uniformly infested with Meadow Eelworm in sufficient numbers to make doubtful the survival of these plants in the field. It has therefore been decided not to use these nurseries and sanction was obtained, and a supplementary vote approved, to construct a large new nursery in a gum clearing adjoining Field No. 14A. This nursery will be approximately 1,000 sq. yd. in extent and will be divided into three sections, *i.e.* one for rooting beds, one for basket plants, and the third section to be rehabilitated for the following year's rooting beds. It will be soundly constructed and supplied with fencing, fumigating shed, and sprinklers. Peat will be used in bed construction. Small areas below the estate office and blocks in Fields Nos. 9 and 10 have been reclaimed and planted up with clonal material. The two bird sanctuaries planted in 1958 comprising 1½ acres in Fields Nos. 13 and 14A have made good growth during the year.

Mossing and Ferning.—All pruned fields were treated with *Limbux*, to control moss and lichen, at 1½ cwt. per acre, using *Birchmeir Senior* sprayers with No. 2 lime-washing jets.

Ferning was once again carried out by estate labour, as opposed to contract, to ensure a better standard of work.

Moss, lichen and ferns are well controlled and present no serious problem.

Working up Poor Areas.—Thatching with Guatemala and *Mana* grass at the rate of 7-8 tons per acre was done in February/March in all clonal areas in Fields Nos. 1 and 10, and in all ravines where supplies were planted out. All available compost was forked into the poorer patches in fields situated towards the eastern end of the estate.

Guatemala grass areas on the estate were manured three times during the year at the recommended application rate of 1 cwt. of Guatemala mixture per acre per application as follows:—

Sulphate of ammonia	5 parts
Saphos phosphate	2½ "
Muriate of potash 60%	1½ "
	9 parts

Manuring.—The practice of applying manure at six-monthly intervals or when a field has yielded between 450 and 500 lb. of made tea per acre since the last application of manure, whichever is the earlier, was continued throughout the year in respect of Fields Nos. 7—14B. The proportion of nitrogen applied to these fields varied between 8 and 9 lb. nitrogen per 100 lb. of crop harvested. Fields Nos. 2 to 6 received a more generous application of manure, the proportion of nitrogen being stepped up to 10 lb. of nitrogen per 100 lb. of crop harvested.

All pruned fields received one deep forking in every alternate row during the first and second applications of manure, following the recommendation that every field should receive at least one deep forking in the cycle. Broadcasting was done at all other times.

The 1952 clonal area in Field No. 10 received 4 applications of T. 488 mixture at the rate of 36 lb. nitrogen per application. The 1954 clonal area (pruned this year) received 3 applications of T. 175 mixture at the rate of 1 oz. per plant per application.

Following the advice of the Agricultural Chemist that all fields on St Coombs should receive one application of dolomite against possible magnesium deficiency, 2 acres in Field No. 1, 2½ acres in Field No. 10 (clonal area), 12¾ acres in Field No. 10, and 26 acres in Field No. 9, were given top dressings of ground dolomitic limestone at the rate of 5 cwt. per acre in July.

The following are details of nitrogen and phosphate applied to individual fields, the mixture used being T.R.I. 488:—

Field No.	Months Manured	1957 N.	1957 P.	Months Manured	1958 N.	1958 P.	Months Manured	1959 N.	1959 P.
1	May	36	17	March	T. 175		April	T. 175	
	August	T. 175		May	T. 175		August	T. 175	
	October	T. 175		September	T. 175		November	T. 175	
	December	T. 175		December	T. 175				
2	February	46	22	March	36	17	May	40	19
	August	36	17	July	50	23	September	40	19
				December	50	23			
3	February	46	22	January	40	19	May	40	19
	August	36	17	July	40	19	October	50	23
				December	40	19			
4	February	56	26	February	46	22	July	40	19
	August	46	22	June	50	23	December	40	19
				December	50	23			
5	June	43	20	May	46	22	February	45	21
	December	36	17	September	50	23	July	45	21
6	May	46	22	March	40	19	February	40	19
	November	40	19	September	40	19	June	50	23
							October	40	19
7	May	40	19	March	53	25	March	43	20
	October	46	22	June	46	22	August	40	19
				October	40	19			
8	April	43	20	February	46	22	April	40	19
	September	46	22	June	53	25	September	40	19
				November	43	20			

Continued

Continuation

Field No.	Months Manured	1957 N.	1957 P.	Months Manured	1958 N.	1958 P.	Months Manured	1959 N.	1959 P.
9	April	46	22	March	46	26	April	36	17
	September	46	22	June	56	26	September	36	17
				November	43	20			
10	April	46	22	March	56	26	February	43	20
	September	46	22	June	46	22	August	40	19
				October	40	19	December	36	17
10	April	36	17	March	36	17	March	36	17
Clonal area	September	36	17	June	40	19	June	36	17
1952 planting	October	36	17	September	40	19	September	36	17
	December	36	17	December	36	17	December	36	17
10	April	36	17	March	T. 175		March	T. 175	
Clonal area	August	T. 175		June	T. 175		July	T. 175	
1954 planting	October	T. 175		September	T. 175		October	T. 175	
	December	T. 175		December	T. 175				
11	May	46	22	March	53	25	March	36	17
	October	46	22	September	43	20	July	46	22
							November	40	19
12	May	43	20	May	53	25	January	53	25
	November	36	17	August	43	20	June	56	26
							October	36	17
13	April	53	25	January	53	25	January	46	22
	September	46	22	May	46	22	June	53	25
				August	43	20	November	40	19
14A	February	46	22	March	59	28	April	36	17
	June	53	25	June	43	20	July	40	19
	October	40	19	November	36	17	November	43	20
14B	February	56	26	March	53	25	April	40	19
	June	56	26	June	56	26	July	46	22
	September	53	25	November	36	17	October	43	20
	December	46	22						

Green Manure and Shade Trees.—The routine supplying and re-supplying of *Grevillea robusta*, *Albizzia sumatrana*, *Albizzia moluccana* and *dadaps* in all pruned fields continued during the year, when weather conditions were favourable. The large *Albizzia moluccana* trees in Fields Nos. 5 and 12 were uprooted. All shade is well regulated with the exception of high shade in Field No. 5. *Sesbania* was planted out in Fields Nos. 4, 9 and 10 (pruned fields) and is growing successfully.

The green-manure nursery behind Junior Staff bungalows Nos. 1-4 has been stocked with next year's supply requirements.

New Clearing.—Tending of plants in the new clearings continued throughout the year and most of the blocks planted in 1955/56 continued to make visible progress and now have a fair cover of clonal tea.

A few vacancies were supplied during the south-west monsoon period. Bending-over was done where necessary and the overall picture is very encouraging.

The detailed position of Field No. 1 is as follows:—

Block No.	Planted	TRI Clone No.	A.	R.	P.	Remarks
41	Oct. 1953	2024	0	3	6.13	Reserved for sale of cuttings
60	June 1954	2025	1	0	29.75	do.
25	June 1957	777	0	2	37.81	do.
			2	2	33.69	

1955/56 planting

26	June 1955	777	0	2	5.25	
28	June 1955	2025	0	1	1.87	
30	July 1955	2025	0	0	6.56	
43	July 1955	2022	0	2	15.50	
44	June 1955	2024	1	0	18.63	
46	June 1955	2024	0	3	37.12	
48	June 1956	2024	0	0	7.87	
49	June 1956	2016	1	1	17.12	
55	June 1956	2022	0	2	1.56	
56	June 1956	2022	0	2	27.62	
59	June 1955	2025	0	0	8.50	
			6	0	27.60	

The following blocks were planted during the south-west monsoon period of 1959:—

1	June 1959	2026	0	0	33.75
3	,,	2025	0	1	28.00
6	,,	777	0	0	38.56
14	,,	2025	0	2	12.81
15	,,	777	0	0	2.62
17	,,	777	0	3	30.31
19	,,	2023	0	3	9.88
20	,,	2025	0	3	00.50
32	,,	2025	0	0	33.63
35	,,	2026	0	1	26.19
37	,,	2023	0	3	3.13
39	,,	2025	0	0	3.56
			5	1	22.94

Seedling planting—south-west monsoon period, June, 1959.—Blocks 10, 12 and 53 were planted with Illuktenne and Kanapediwattie seed (extent 1A. 3R. 34.18P.). The total acreage at present in tea in Field No. 1 is 16A. 0R. 38.41P.

Lining and holing began in April and actual planting operations commenced in the last week in May. All plants have been bent over three to four times and subsidiary growth has been excellent.

Blocks planted in 1953/54 and 1955/56 received the T. 175 mixture on the basis of 1 oz. per plant, at four applications per annum, with magnesium sulphate 24%. Blocks planted in 1959 received two applications of Sterameal 'A' at 1 oz. per plant. Compost and well-rotted cattle manure was applied to weak areas. The whole planted area was thatched twice during the year with Guatemala and *Mana* grass. Drought conditions during the early part of the year affected plants to a slight degree.

Wherever necessary, terracing and masonry work in ravines and steep faces continued during the year.

Guatemala grass in the remaining areas, which are being reconditioned, was lopped three times during the year and manured at the rate of 4 cwt. of fertiliser per acre per application. The whole area now in tea was planted up with *Grevillea*, *Albizzia sumatrana*, *Albizzia moluccana*, *dadap*, *Sesbania* and *Acacia pruinosa* and these are well established and excellent results have been obtained.

Wind-breaks across the path of the south-west monsoon winds have been planted with *Acacia pruinosa* and this appears to be an excellent tree for the purpose. Certain poor areas, in particular a part of Block 44 (planted June 1955—clone TRI 2024) in less favourable land, have been given a very heavy thatch with Guatemala grass. The area to be planted in 1960 (Blocks 8A and 8B—about 2 acres) has been rehabilitated for 3 years under Guatemala grass. Sufficient clonal material is available in No. 1 nursery for the 1960 planting, but before any of this is used, a careful survey will be carried out by the Nematology Division on the degree of Meadow Eelworm infestation. However, it is hoped soon to put down sufficient cuttings in the new nursery for the 1960 planting, in case existing material is unsuitable.

Factory and Machinery.—Considerable general improvements were carried out to the factory in 1957 and 1958. During the year under review, attention was given to standardising the machinery in the sifting room and individual AC motors were fitted to the Suction Picker, Extractor Fan, Tarry Nipper Breaker, and Michie Sifter; and a certain amount of re-arrangement of machinery took place. A conveyor belt to feed the Brown's Winnower was installed and is working satisfactorily. An Electric Stalk Extractor was also installed and has proved to be a boon, considerably reducing the cost of red leaf picking.

The furnace of the Marshall's Drier was completely overhauled in April and the Heat Exchanger unit was installed by Messrs Brown & Co. Ltd., in May, but it was not possible for tests to be carried out as the Marshall's Drier was used for manufacture and withering regularly during this period. The erection of 5 new bays of tats in the bottom left loft of the factory was completed in April and new jute hessian was laid for tats in the middle right loft.

The table of No. 4 roller was dismantled in April and sent in for a complete overhaul to the worn out battens and cone. A visit of inspection was made by the Chief Inspector of Factories, Department of Labour, on Tuesday, 20th October, concerning safety devices for all machinery (Factory Ordinance No. 45 of 1942, and 22 of 1946). It will be of interest to note that all machinery in the factory is inadequately protected and provision will therefore have to be made to install adequate safeguard measures during 1960. Lloyds' Survey Inspection was carried out on Wednesday, 28th October by Messrs Lloyds Survey Inspection Department, to inspect all fire-fighting appliances.

Labour.—11 children and 4 brides were registered during the year and only 1 labourer retired on the new scale of old-age gratuities. Generally the labour force co-operated with the management throughout the year and there was no unrest. Health was generally good.

	Men	Women	Children	Total
Working labourers on estate as at 31st December ...	250	231	17	498
Non-working	12	15	464	491
Total ...	262	246	481	989

Working labourers per cultivated acre was 1.71 and the percentage of out-turn was 80%. The figure of 1.71 labourers per cultivated acre is higher than normal, but approximately 1/6th of all labour is required by the Institute for experimental work. Twelve labourers have expressed a wish to be repatriated to India and every encouragement will be given them. It is proposed to restrict the working force to 500 and no extra registrations will be made.

Looking to the future, it is apparent that a serious problem will present itself within the next five years in view of the extremely high natural increase.

Lines.—The total number of units, all up to Government standard, is 213 (32 sets of lines). The number of workers per room is 2.34 and the number of souls per room is 4.70.

During 1959 the roof of No. 8 line was removed and new galvanized iron sheets substituted. Several roofs were also painted.

Another cattle shed to accommodate six head of cattle was built. There are at present on St Coombs 77 head of cattle and 99 goats. The fly nuisance during the dry weather continued to be serious.

The old school, which was converted to accommodate two large families, will have to be dismantled shortly, as this building is unsafe and unfit for human habitation. Line No. 27—4 rooms situated behind the present cadday —is to be demolished in 1960.

Manufacture.—There was no deviation from the type of manufacture adopted in previous years. From January to April a 4-roll programme was adopted during the quality months and manufacture started in the small hours of the morning. When crop increased in May and June and weather conditions were unfavourable for the presence of flavour, continuous rolling was carried out. Subsequently, as crops decreased, a 5-roll programme was reverted to and this continued until the end of the year.

The percentage of dhools obtained on a 5-roll programme follows:

1st dhool	20%
2nd dhool	24%
3rd dhool	22%
4th dhool	15%
5th dhool	14%
Big Bulk	4%

The length of the rolling period was 130 minutes and the total time allowed for charging was 70 minutes. The average fermentation period was 3 hours.

Grade percentages.—

	1959	1958
B.O.P.	72.95	72.86
B.O.P. Fgs.	8.28	8.31
F. Pekoe	3.01	2.72
Fannings No. 2 ...	3.82	3.63
Orange Pekoe ...	.42	1.58
Broken Mixed No. 1 ...	6.69	5.92
Dust No. 1	4.43	4.50
Experimental teas ...	.40	.48
	100.00%	100.00%

Out-turn of made tea to green leaf ... 21.65%

Visiting Agent.—Mr Alexander Mackie, who succeeded Mr G. K. Newton as Visiting Agent, paid his first official visit to St Coombs on 21st December, 1959.

General.—The year under review has been quite a satisfactory one. Profits will certainly be far lower per acre than last year but 1958 was an exceptional year both for crop and for prices. In view of unfavourable weather conditions at the beginning of the year and the scale of *ad valorem* duty imposed with effect from 1st June, the final result must be considered to be very satisfactory.

The general appearance of the tea is excellent. Prices have been well above average and altogether a sound agricultural policy has been followed throughout the year. The factory is well equipped to take in larger crops. V.P. clearings which gave much cause for anxiety in the past, have improved beyond recognition and clearings planted during the year under review show promise of developing into excellent fields of tea. Given generally favourable weather conditions, we look forward to a good season in 1960.

METEOROLOGICAL OBSERVATIONS - 1959
ST COOMBS
(Laboratory Gauges)

MONTH	TEMPERATURE °F						Mean Relative Humidity	RAINFALL		RAINY DAYS		SUNSHINE	
	Mean Maximum	Difference from Average (25 years)	Mean Minimum	Difference from Average (25 years)	Adopted Mean	Mean on Grass		Inches	Difference from Average (25 years)	Days	Difference from Average (25 years)	Hours	Difference from average (25 years)
January ...	74.5	+ 0.4	52.2	— 3.5	63.4	49.4	76	2.54	— 1.06	8	— 3	245.45	+ 52.75
February ...	76.0	— 0.3	52.4	— 2.2	64.2	43.8	84	2.68	+ 0.33	5	— 3	243.33	+ 32.65
March ...	77.5	— 0.2	51.8	— 3.7	64.7	45.9	51	1.04	— 3.50	4	— 8	286.10	+ 53.09
April ...	75.7	— 1.7	58.0	+ 0.2	66.9	56.5	82	7.62	+ 1.25	17	+ 1	190.52	— 5.92
May ...	75.7	+ 3.3	59.3	— 0.4	67.5	59.3	72	10.38	— 0.90	22	+ 4	175.75	+ 11.75
June ...	69.7	— 0.9	61.1	+ 0.7	65.4	59.5	86	20.25	+ 7.15	27	+ 1	45.70	— 46.34
July ...	67.8	— 2.4	60.3	+ 0.8	64.1	62.5	90	15.11	+ 3.37	25	— 1	72.40	— 32.79
August ...	70.8	— 0.2	59.3	+ 0.1	65.1	59.6	84	7.37	— 2.05	22	— 3	155.70	+ 41.54
September ...	71.0	— 1.2	59.2	+ 1.0	65.1	59.6	85	7.69	— 0.68	25	+ 4	114.25	— 26.07
October ...	71.9	— 1.2	58.8	+ 1.1	65.4	59.2	84	9.82	+ 0.13	21	— 1	147.55	— 1.81
November ...	72.1	— 1.4	55.6	— 1.5	63.9	55.0	79	5.29	— 2.13	18	— 1	138.10	— 23.42
December ...	73.4	— 0.1	57.1	+ 1.0	65.3	53.1	77	3.26	— 1.96	15	—	179.07	+ 9.84
	73.0	— 5.9	57.1	— 6.4	65.1	55.3	79	93.05	— 0.5	209	— 10	1993.92	+ 65.27
	Means							Totals					

REPORT OF THE CHIEF ADVISORY OFFICER FOR 1959

C. B. Foster-Barham, M.A.

The new Advisory Division began operations in the latter half of November, and now deals with all correspondence from tea estates on questions of crop husbandry; these were formerly handled by the separate research divisions of the Institute. Correspondence on manufacturing problems, on the other hand, does not come to me, but is handled by the Technologist. All letters should, of course, be addressed impersonally to the Director.

In the few weeks to the end of the year, 109 letters were received and 106 sent out; and 10 visits were made to estates.

A temporary office was established in the Physiology Division; reconstructed accommodation in the other wing was expected to be ready in January 1960.

Mr L. M. de W. Tillekeratne, Senior Technical Assistant in the Plant Physiology Department, was transfered to the Advisory Division in November. Mr D. J. M. Hettiarachi took up duties as Photographer on the 1st of January, 1960; he will make a collection of photographic material for research publications, for incorporation into a new series of Advisory Leaflets, and for the extension of the photographic gallery.

REPORT OF THE LOW-COUNTRY ADVISER FOR 1959

A. W. R. Joachim, O.B.E., Ph. D.

Administrative.—The local activities of the Low-country Division, which had been suspended while I was functioning as Director of the Institute, were resumed in October. The new headquarters were established at Ratnapura, the most suitable place for the preparatory work at Mutwagalla Estate, which had been selected for the sub-station and was in the process of being acquired for the Institute under the Land Acquisition Act. There were, however, a number of unexpected difficulties and, in order to surmount these, the Board decided, at the end of the year, to ask for the release of only about 50 acres of the estate, so that the construction of the essential buildings and urgent experimental work on vegetative propagation could be begun. It was hoped that these activities could be started very early in 1960. In the meantime, three technical officers were recruited for the sub-station and were being trained at St Coombs. One of them, Mr A. E. T. Ellawala, assumed duties at Ratnapura. In the upshot, early in 1960 the idea of buying Mutwagalla had to be abandoned and a search for another suitable estate was begun.

In regard to the vegetative-propagation unit or clonal-testing station for the Galle District, it was decided to take over the land made available for the purpose by Government at Kottawa.

Extension and Advisory Work.—Since my resumption of duties at Ratnapura, every opportunity has been taken to re-establish contacts with planting bodies and individual estates, in order to familiarize myself with developments in tea cultivation and manufacture in the area since March 1958 and to ascertain their problems and viewpoints. Accordingly, meetings of Low-country Planters' Associations were attended during the period, and 28 visits to estates were made; 278 letters have been written since October; and I have paid 17 visits to Mutwagalla and Endane Estates for administrative or experimental purposes. At the P.A. meetings, short addresses were given, mainly on the present position in regard to the Low-country Sub-station. Estate visits were as follows, classified according to Districts: Ratnapura 11, Galle 4, Kalutara 4, Deniyaya 3, Kelani Valley 3 and Balangoda 3. Included among these was a visit to the State Tea Plantation at Pelwatte which was both interesting and encouraging, as I had recommended the area for development under tea in 1957 after an air and ground survey of the land, the former in the company of Mr A. Watt, Visiting Agent of the plantation.

A preliminary reconnaisance was undertaken of a large extent of land to be developed as a tea-colonization scheme in the Hiniduma Pattu of the Galle District. It was obvious that great care would be necessary in alienating lands in this area for the purpose, as much of the land is either very rocky or too steep. A short time before I assumed duties in the low country, a survey of typical tea-colonization schemes in the zone was carried out, at the instance of

Government, along with the then Superintendent of St Coombs, and a report was issued thereon. If the suggestions made are put into practice, there is reason to hope that, provided a suitable type of colonist is selected, under the capable direction of the present Visiting Agents, these schemes could make a substantial contribution to the improvement of the economic conditions of the colonists settled under them.

Experimental Work.—With the re-establishment of the Low-country Division, the experimental work carried out at Endane Estate on manurial and cultural problems was transferred to my administrative control. The three experiments are as follows:

(i) Manuring Experiments.—These were started in 1955 and were designed to test the effects on old tea of four nutrients, namely nitrogen, potash and magnesium at three levels, and calcium, applied as gypsum, at two levels. Phosphate was kept constant. The trial is now in its third cycle, of approximately 18 months duration, which will be completed in April 1960. So far there have been no significant differences between the results from the various treatments. This is very unexpected, particularly in respect of nitrogen, where applications of 80, 120 and 160 lb. per acre per annum all gave yields of about 1600 lb. per acre per annum. The reasons for these findings are to be investigated, from the chemical standpoint, in 1960; but the number of bushes in the experimental area (only about 3250 on the average) is likely to be an important contributory factor. At Endane itself, on a ten-year-old field of 42 acres that is patterned for 6,000 bushes per acre and probably actually carries about 5,500, the average yield for the past three years, including the pruning year, has been over 2,400 lb. per acre, with manuring at 10 lb. of nitrogen per 100 lb. of crop. In the Sapumalkande trial, where an annual average yield of 3,000 lb. per acre is obtained, the bush stand is over 7,000 to the acre, and the annual nitrogen application 160 lb. per acre. On another low-country estate, an annual yield of over 2,500 lb. per acre is obtained on a 12-acre block of 11-year-old seedling tea receiving a total of 140 lb. of nitrogen per acre per annum. The stand here is over 6,000 bushes to the acre. In the low country, present modern stands number about 5,000 bushes per acre of seedling tea.

(ii) Cultural Trials.—Two trials were started by the Plant Physiology Division in 1956 respectively. They are as follows:

(*a*) Pruning-cum-plucking experiment.—This includes 12 treatments, these being combinations of 3 pruning cycles ($1\frac{1}{2}$, 2 and 3 years), 2 levels of manuring (nitrogen at 8 and 10 lb. per 100 lb. crop), and 2 types of plucking (single-leaf, and single-leaf followed by fish-leaf). The results will be detailed by the Physiologist but they indicate, so far, that the 18-month cycle is superior to the 3-year cycle under the conditions at Endane, and that single-leaf followed by fish-leaf plucking does give a higher yield than single-leaf plucking. Time alone will show, as at St Coombs, whether the former plucking method will have deleterious effects on maintenance leaf and on the bush frame.

(*b*) Bringing-into-bearing trial.—In this trial, thumb-nailing, bending and cutting across (by two methods), and centering are compared. The plots have only just come into plucking and accordingly no comments are made.

Observational.—The following observations, supplementary to those made in my annual reports of 1956 and 1957, are results of visits made to estates since my return to the low country:

(a) **Vegetative Propagation.**—Considerable progress has been made on a number of estates with the vegetative propagation of tea, notably at Palmgarden, Endane, Enselwatte, Ederapolla and Pelmadulla, and several others have planned annual programmes of development. The clones most commonly cultivated are the TRI 202 series, but a few of the estates have developed promising clones of their own. Most of the areas under V.P. are old rubber lands and only relatively small extents are old tea lands. Yield data obtained on areas of V.P. in plucking are well up to expectation. What is now strongly indicated is the need for information of the nutrient requirements of these clones under low-country conditions of high rainfall and high temperature so that continuity of high yields and bush vigour can be maintained. It is already apparent that some clones, *e.g.* TRI 2021 and TRI 2023, are susceptible to magnesium deficiency, particularly on old rubber land, and the Institute's recommendation to incorporate some magnesium sulphate in young-tea mixtures is timely.

A number of estates are using V.P. material for resupplying. Palmgarden Estate, in particular, has made a striking success of this practice by transferring Hersall or basket plants about a year old to comparatively shallow but large holes filled with soil that has been well mixed with compost or organic material. Polythene sleeves are being used successfully and more economically than bamboo baskets by this estate and a few others, as containers for V.P. plants. A point of interest, in regard to the selection of cuttings for rooting, is the stage of maturity of the cuttings in respect of flowering: attention has been drawn to this matter in the Bulletin on Vegetative Propagation by Dr Visser (1959). A remarkable difference was noted at Balangoda Group in V.P. bushes propagated from cuttings taken from the same mother bush but at different times, *i.e.* when the bush was in its vegetative and its "primordial" phases.

(b) **Pruning cycles and methods.**—There appears to be less enthusiasm now for the reversed rim-lung (pre-prune) system of pruning; but interest has been shown in the half-prune—a modification of the pre-prune system which is being tried out experimentally on some Uva estates—and one estate has reported that a very satisfactory result has been obtained. In regard to the duration of the pruning cycle, while a few estates, particularly in the Galle District, adopt the 3-year cycle, the practice is not generally looked on with favour, and in one instance in the Kelani Valley the result was disastrous.

(c) **The establishment of green manures.**—The application of from 50 to 100 lb. of saphos phosphate along the line of rows of *Crotalaria* seed on a block of new tea on eroded soil, where the green-manure crop had made poor growth, has given very good results. One estate reports that the regular application of about a handful of lime to a green-manure tree produces excellent results. Dolomitic limestone is suggested for trial instead.

Green-manure bush plants need to be cut down or lopped to a reasonable height, if they are not to compete with the young tea plants for moisture during drought periods, to the detriment of the tea. The loppings, used as mulch, are an additional source of moisture conservation. Cover crops, particularly on sandy soils, can react very adversely on young tea, if allowed to grow during the dry season.

General.—Tea production in the low country has shown a remarkable advance since 1955 in regard to both yield per acre and total production. The table below bears this out.

Year	Average Yield (lb. per acre)	Production (million lb.)
1955 ...	532	75.7
1956 ...	584	80.6
1957 ...	649	89.9
1958 ...	710	99.7

The yield per acre has risen by 33 per cent during the three-year period and there are good indications that this rise will continue. Against this, the all-Island average yield of tea has increased by approximately 7.5 per cent (from 671 to 722 lb. per acre) and the up-country average by 12 per cent (from 785 to 855 lb. per acre). It is apparent that the low-country tea industry is now on the march and, with the appreciable increases in average prices obtained for low-country teas (from Rs. 1/48 to Rs. 1/90 approximately) following the introduction of the *ad valorem* tax *cum* export-duty scheme of taxation in June, there is bound to be an appreciably increased contribution by the low country to the tea output of the Island and to its economic welfare. The establishment of a low-country sub-station could not be more opportune.

Reference

Visser, T. (1959). Propagation of tea cuttings. III—The influence of the nodal leaf on rooting, growth and flower development. *Tea Res. Inst. Ceylon Bull.* (new series) no. 1 : 32–40.

REPORT OF THE AGRICULTURAL CHEMIST FOR 1959

J. A. H. Tolhurst, B.Sc.

Staff.—The year began with two set-backs, the resignation of the Research Assistant, Mr S. Selvaratnam, to take up a teaching post at the University of Ceylon, and the transfer of Mr T. S. Nathan, Technical Assistant, to the Biochemistry Division. The Board had approved a second Research Assistant, but only one suitable appointment could be made. This took effect from the beginning of 1960.

Mr E. N. Perera, the Senior Technical Assistant, came back after a severe illness, but after a gallant effort he decided to retire at the end of the year. A replacement has not yet been found. Mr Perera had been in the service of the Institute from the pioneering days in the temporary laboratory in Nuwara Eliya, and had given devoted service for over thirty years.

Three additional Assistant posts were approved by the Board, two for laboratory work and one primarily for field duties. The two Technical Assistants began duties in the middle of the year: Mr T. C. Z. Jayman had had valuable experience in corresponding analytical duties in a sister Institute, and Mr E. O. Steuart filled the junior of the two posts. The Field Assistant post was filled by Mr R. Balthazaar, also with experience of similar duties, who will take up the appointment in 1960.

These and the hoped-for future appointments will provide the long-awaited basis for the establishment of a balanced team and will resolve the past difficulty experienced by one officer in conducting both field and laboratory work.

Mr V. Mendis, now the senior Technical Assistant, and Mr S. Samarasingam, Field Assistant, continued duties as before. I continued as Acting Biochemist, pending finalization of the staffing of that Division.

A.—FIELD EXPERIMENTS

Very few changes were made in the administration of the experiments listed in the Annual Report for 1958. A most welcome modification resulted from Dr A. W. R. Joachim's return to the low country and his acceptance of responsibility for the detailed supervision of the large and complex Endane manurial trial. For convenience the report on this trial for 1959 is included here.

Following preliminary examination of the various manurial trials, it was agreed that assistance should be sought from an experienced statistician, and we were fortunate to have a visit from Dr S. C. Pearce, Head of the Statistics Department of East Malling Research Station. During nearly two months Dr Pearce not only evaluated the mathematical significance of results which

had accumulated over a considerable number of years, but also offered invaluable advice on the statistically desirable modifications to the trials. Certain of his findings and recommendations are embodied in the following reports.

1. **Low-country Manurial Experiments.**—Both experiments, on Endane estate and on Sapumalkande estate, have continued unchanged during 1959 and again we express grateful thanks to Messrs A. Watt and E. N. Whitfield respectively for their co-operation.

The Sapumalkande experiment was pruned in August and the treatment totals for the eighteen-month cycle showed no appreciable differences. The general level of yield was 3,100 lb. per acre per annum (made-tea equivalent). Detailed chemical analysis is in hand, and no change in treatments is contemplated until that is finished.

The Endane experiment, having been pruned in October of the previous year (1958), was tipped twice, in December and in January 1959, and is now approaching the end of its 3rd cycle. It is possible, without prejudging happenings in the remaining four months of the cycle, to comment on certain trends. The most interesting occurred at tipping, when a significant increase in yield was associated with the higher calcium treatment. From the start, all plots have received a uniform basal dressing of rock phosphate, which contains calcium, but a higher calcium treatment was introduced at the beginning of the 2nd cycle in the form of gypsum (hydrated calcium sulphate) so as to double the basal dressing. Three of the six replicates were treated in this way, giving a split-plot design to the trial. It is noteworthy that no effect of the higher calcium was to be seen in the yields in the 2nd cycle, whereas an effect was immediately apparent as soon as the 3rd cycle began. The fresh weight of tippings per acre in this third cycle were 504 lb with the basal calcium and 581 lb with additional calcium, a difference that was significant at the 5% level.

It is presumed that this effect is due to the calcium ion but the precise determination of the reasons must await chemical investigation. The benefit from additional calcium was reflected in succeeding plucking rounds, but by the twentieth round the difference in yields had fallen to about 5% and by the end of 1959 the trend appears to have been completely reversed. This result is thus of added interest as, apart from being the first significant result from this large and sensitive experiment and also providing our first indication of a calcium effect on the yield of tea, it appears to point to the need to consider the possibility of differential manuring in relation to the stage of the cycle. The question of the delay in response until after the pruning in 1958 will be considered in the discussion on the No. 3 Field Experiment at St Coombs.

Regarding other treatments, magnesium additions have shown no consistent trends. Increasing nitrogen and potassium rates have *not* given increases in yield, and in fact there is a slight but consistent trend in the opposite direction. In view of the levels employed for a yield of approximately 1,700 lbs per acre per annum, namely:

Nitrogen	—	80, 120 and 160 lb/acre/annum
Potassium (K_2O)	—	60, 90 and 120 lb/acre/annum

this trend is unexpected and will be subjected to intensive investigation.

Late in 1959, observation suggested that a manganese toxicity chlorosis (see below) was increasing in frequency. This could be expected to increase during the drier weather at the beginning of the coming year, when it is hoped to undertake detailed sampling of leaf and soil.

2. **Passara Manurial Experiment.**—Certain features in the original design of this trial seem to indicate that the greatest possible amount of information has now been obtained, but a final decision on the future of the experiment has yet to be made.

3. **Modified Phosphate Experiment: St Coombs No. 13 Field.**—On statistical grounds it was found to be necessary to remove a superimposed treatment, involving frequency of application of manure and, since the present cycle is due to end early in 1960, the opportunity will then be taken to simplify the design. It is intended to concentrate attention on the relative effects of superphosphate and rock phosphate in regard to the interpretation of certain effects resulting from superphosphate treatments in the No. 3 Field manurial trial (see below).

4. **N.P.K. Experiment: St Coombs No. 3 Field.**—As foreshadowed in the 1958 Annual Report, this trial has undergone drastic modification and has occupied a great deal of the time of this Division, in tabulation and inspection of yield records accumulated since 1931, and in making detailed observations in the field both before and after changes in treatment. Early in the year the plots were examined by a sub-committee consisting of the appropriate Institute officers together with Messrs R. C. P. Adams and C. M. G. Moberly, of the Experimental and Estate Committee, in order to choose the method of pruning to be adopted. To these members we offer our thanks, and in particular to Mr T. B. Pethiyagoda, lately Superintendent of St Coombs, for organising the labourers for a type of pruning which was quite unfamiliar to them.

A brief comment on certain trends over the past twenty-eight years may be inserted here. Not all the trends observable by inspection of the records attain statistical significance, but the intricacy of the trial, especially in the earlier cycles, was such that quite large differences between yields from certain treatments could often escape the mathematical test. Perhaps the most important result, and one which seems to have escaped sufficient attention, occurred within the first ten or twelve years of the trial. In the first two cycles, each of three years, nitrogen was applied at three levels:

N: 0, 20 and 40 lb per acre per annum.

It was observed that yields fell from the 1st to the 2nd cycle, and therefore at the commencement of the 3rd cycle the nitrogen treatments were increased to the level which they have maintained ever since:

N: 40, 60 and 80 lb per acre per annum.

Contrary to expectation, yields of all treatments in the 3rd cycle were below those of the 2nd, and the decrease was very marked. Inspection of yields for six-monthly periods throughout the 3rd cycle showed no improvement. However, as soon as the 4th cycle began, with no alteration in treatments, yields of both tippings and of plucks showed a startling increase, particularly in the treatments including N. 80. Thus, increasing the nitrogen had had no effect on yield of flush over a three-year period following a pruning, but the immediate response after a subsequent pruning showed that the bush itself had in fact responded, but in a way that was not shown in the yield records. Weights of wood removed at pruning for the first four cycles offer a suggestion

as to a reason for the trends. From a little over half a pound of air-dry wood per bush removed at the conclusion of the 1st cycle, the weights increased to about one and a half pounds at the conclusion of the 4th cycle. Half a pound of pruning wood is, of course, a low weight and unfortunately records are not available to complete the picture and to enable us to decide if that weight represented very light pruning on a normal bush or normal pruning on a very small frame. It is probably safe to assume that the frames were increasing rapidly from the 1st to the 4th cycles. If so, the apparently peculiar trends in yields could be taken as vindication of the insistence of the Institute that long-period yield of flush is indissolubly linked with over-all bush vigour and, as a corollary, that manuring is aimed at building up a strong bush so that judicious management can then obtain as much flush as the bush can produce. This dictum can never be over-emphasised, but the idea that routine manuring can be so adjusted as to produce flush, as opposed to wood, still clings tenaciously.

The need for a balance between the potash and phosphate manures has been consistently shown by this trial, although the fulcrum of the balance has shifted in recent years. This shift, suggesting a higher potash-to-phosphate ratio than has been employed hitherto, is not easy to explain, since the treatments cover a very wide range of each nutrient, including a zero level of each. Thus, until we can estimate the supply from soil reserves, we shall be unable to judge just what the zero treatments for potash and phosphate imply. An indication may be obtained from observation of the plots receiving 20 lb of potash (K_2O) per acre per annum, that is, the second level in the range 0; 20, and 40 lb. K_2O. In 1958 and 1959 individual bushes on many of these plots showed appreciable symptoms of potash deficiency, and this was in accordance with the tendency in recent cycles for the yields from these treatments to fall markedly compared with the K.40 treatments. In the earlier cycles the K. 20 yields had been as high as those from K. 40 and it would have been excusable to assume that the lower level of potash was adequate. In fact, the soil reserves of potash were playing an unknown but obviously important part in maintaining the yields. A similar picture may eventually emerge for the phosphate treatments, as in several of the P.0 plots, leaf symptoms were observed in 1959 which suggest a deficiency level of phosphate in the bush, and analyses so far done support this idea. No detailed report will be made until work has been done on the shoots after pruning, when phosphate deficiency would be expected to be more in evidence and more damaging.

These points offer yet more support to our constantly reiterated plea to consider manuring as a long-term policy, and they also stress the need for continuance of manurial trials for long periods.

The position in 1959 was that obviously poor yields and equally obvious damage to the frames had to be evaluated in relation (*a*) to the past manurial treatments in this trial, (*b*) to results from other trials and (*c*) to results from general estate practice over the past decade. Damage resulting from withholding potash for twenty-eight years was apparent enough; and a similar effect from withholding phosphate, and therefore calcium as well, for twenty-five years could be tentatively assumed. However, certain treatments had approximated to the standard manure, T. 500, at an annual rate of 80 lb. N for twenty-two years, preceded by a lower rate of nitrogen, and the condition of the plots concerned did not appear to reflect credit on such generous manuring. Elucidation of the many interacting factors will probably never be made satisfactorily but an answer of some sort was necessary to try to justify past manuring and to decide on the future course of the trial.

Fortunately, from the manurial aspect, detailed examination of the bushes suggested that the main factor contributing to the poor condition of the bushes was severe wood-rot distributed regardless of manurial treatments, but bearing a relation to the degree of exposure of the plots. Further, by observation of recently formed branches and by consideration of meteorological data, it was deduced that the late November pruning in 1949 was probably the cause of the damage, offering entry to the wood-rot organisms. The 6th cycle had been extended for six months in order to obtain recovery free from Blister Blight, but unfortunately the dry weather began in December of 1949, one month after pruning, and continued until March 1950 with unusual severity. Absence of shade on the plots, mostly sited in exposed areas, and lack of manure to compensate for the extension of the 6th cycle, no doubt helped to weaken bud break, but it is doubtful if anything could have prevented sun scorch of the bare limbs early in 1950. In 1959, after pruning, it was possible to see the remains of large limbs, of 4 inches diameter or more at the base, which were hollowed out and which had rotted into the trunk, or even into the root-stock. A few bushes had been reduced to hollow crowns with main roots also hollow. Although this damage was not related to manurial treatments, the formation of *new* branches and stems, from the bases of the trunks or from roots, appeared to be more vigorous in those plots receiving the higher doses of reasonably well balanced mixtures.

The rehabilitation pruning was designed to facilitate formation of new branches from as low in the frame as possible, or to encourage growth of shoots well away from the central mass of any bush that had lost or had never possessed a true trunk. One third to one half of the limbs were sawn off at their bases, and the remaining limbs were clean pruned drastically. It was observed that thin twigs had often given rise to large pockets of wood rot, sometimes causing serious damage to the trunk itself. Although a few bushes had to be collar pruned, the majority were allowed to keep several single shoots up to a foot in length, wherever these existed in sufficient vigour. Large cuts were painted with tar and the worst of the rotten centres were scraped out. The whole operation was most tedious, as the bushes required individual treatment. It may be said that credit is also due to the labourers who showed a ready appreciation of the principles involved.

Pruning occupied five weeks, for the four and a quarter acres, in July to August, the tea having been rested since January. Bud break from the thinner and younger shoots began late in September, but from the large branches and trunks no appreciable bud break occurred until late October. The number of buds which had broken by the end of 1959 was encouragingly large, and in fact, in some instances there were so many from the thinner wood as to suggest abnormality. As the present cycle, the 10th, is only intended to run for a short period, depending on rate of growth, the profusion of shoots from the centres of some of the bushes will serve to build up food reserves in the root-stocks and will be removed at the following pruning before they are able to compete unduly with the fewer shoots from the sides. At the time of writing the vigour of growth of the shoots emphasises the effects of absence of potash or phosphate from some treatments, and on other treatments suggests that the bushes carried more reserves than the yields might have indicated. Thus we may again have added support for the contention that poor frames cannot respond to manure, in respect of yield of flush, to the same degree as is shown by normally healthy frames.

Casualties resulting from the hard prune were fewer than have been recorded at previous light cut-across prunes. By the end of the year, four or five months after pruning, it was apparent that ample foliage was present to

protect the frames during the 1960 dry season, although the vigour of the shoots was only moderate.

Changes were also made in the application of manure and in cultivation, but it has not yet been possible to establish a stand of shade. Manure was broadcast in both rows in January before starting the six-month resting period, and again broadcast in November, when shoot growth showed signs of responding rapidly to the favourable weather conditions. Each application consisted of half the usual annual dose, according to the particular treatment applied in past years, and it is intended to continue in this manner, rather than to follow the past practice of applying the whole annual dose in alternate rows once in a year, sometimes during the monsoon months. Similarly, the traditional vigorous deep forking, which has led to serious erosion of drains in the small plots, has been stopped and forking will be done only when considered necessary and at appropriate seasons.

During the present rehabilitation cycle no importance is attached to yields but every effort is being made to bring the more highly manured plots into a condition in which they can in future cycles respond to manure, applied in a rational manner in accordance with the response which they showed before 1949 and which is nowadays expected from estate tea. Certain extreme manurial treatments have obviously caused permanent damage and although they will thereby upset the design of the experiment as a whole, taken individually they will provide invaluable experimental material for studies in plant nutrition. A promising start has been made on these lines and is reported below under appropriate headings.

B.—PLANT NUTRITION

The recently acquired freedom to make detailed sampling and minor experiments within the long-term manurial trials gave welcome impetus to a systematic study of plant-soil relations. Such work could not have been attempted without an increase of staff, because the operations in the field make heavy demands on the time and skill of assistants and, further, often require prompt laboratory support to guide field planning before a critical season or stage of growth has passed. On the credit side is the fact that the results from short-term, fundamental, nutrition experiments can give useful guidance to the selection of both treatments and sites for elaborate long-term trials. They can also include extreme treatments which would not be considered practicable for a long-term trial and might then assist us to predict future developments without risking the permanent health of a part of an intricately designed experiment.

1. **Boron.**—An illustration of the secondary nutritional effects often to be found in simple manurial trials was given by the results of boron analyses on mature leaves taken from the No. 3 Field N.P.K. trial early in 1959. A clear relation between boron content of the leaf and the amount of potassium supplied in the manure mixtures was shown in the no-calcium plots.

TABLE 1.—*Boron content of mature leaf: parts of boron in a million parts of dry matter. No. 3 Field N.P.K. Experiment, St Coombs.*

CaO lb. per acre per annum	0			60			120		
K_2O lb. per acre per annum	0	20	40	0	20	40	0	20	40
Block A	41	50	57	36	39	33	37	35	37
,, B	32	44	58	28	31	33	30	30	34
,, C	32	45	58	39	33	31	31	19	32
,, D	38	49	62	34	28	32	38	30	31
,, E	40	28	63	36	35	34	38	31	36
,, F	46	52	72	37	31	31	39	30	25
Mean of 6	38	45	61	35	33	32	35	29	33

Analyses of similar mature leaves from tea in various stages of development and from widely separated climatic zones suggested that 30 p.p.m. of boron was a common concentration, but it is necessary to carry investigations further, even if the above trends should be peculiar to that experiment. Preliminary experiments have begun, including treatments aimed at inducing obvious boron toxicity, symptoms of which have already been obtained. The rapidly growing shoots on the above N.P.K. trial are being closely watched, since it is possible that the calcium-potassium effect might induce a temporary deficiency of boron in the growing points, with serious consequences at this critical stage. Boron contents in the growing points and immature leaves would be expected to be lower than those in the mature leaves.

Soil analysis, by means of the usual water extraction, has so far shown generally very low boron contents and further attempts at fractionation are planned.

2. **Iron Deficiency.**—Before the No. 3 Field N.P.K. trial was pruned, several bushes were observed, during the drought from January to March, to show chlorotic tip leaves with a pattern typical of iron deficiency in many crops. The leaves were thin and pale yellow-green, or yellow in severe instances, and showed a distinct reticulate pattern of green veins. This pattern tended to be uniformly distributed over the leaf, with the exception that in the most severely chlorotic leaves the tips and margins became yellowish white, with even the fine veins losing their colour in this zone. In the early stages of development the pale green leaves could be confused with nitrogen-deficient leaves on casual observation, but severe nitrogen deficiency gives rise to uniformly yellowish leaves, sometimes nearly white and occasionally with a pinkish tinge, without a green network of veins.

Spraying with ferrous sulphate effected a more or less complete greening of the iron-deficient leaves. The chlorosis disappeared rapidly once the pre-monsoon rains started, and had just been re-observed on the tips of vigorous shoots on the pruned plots of the same experiment late in December. The same symptom was observed on plants of TRI 2021 running up for cuttings, and on a vigorous field recovering from pruning, both on St Coombs.

In its present form, this nutritional imbalance is of minor importance, but its appearance may be of value in assessing the adequacy or otherwise of other nutrients. For example, the original observations showed a tendency for this chlorosis to be associated with potash-deficient plots in the N.P.K. trial. Certainly, iron deficiency, which in itself is an inaccurate term, cannot be considered in isolation; and analyses have already shown that the expected complexities exist in the material studied.

3. **Manganese Toxicity.**—Although the main danger of an excess of manganese is to give the effect of a deficiency of iron in the foliage, this disorder has been considered separately as it is believed that the causes are different from those that give rise to the iron deficiency mentioned above. The symptoms shown very strikingly by the leaves also differ in some respects, the most important of which is that leaves carrying excessive concentrations of manganese can be of normal size and thickness. Usually the chlorosis is less evident near the mid-rib and the smallest veins may not be so prominently green as in the iron-deficient symptoms already described.

The non-chlorotic areas of the leaf remain a normal green. A point of similarity is that the manganese-toxicity symptoms become most obvious in dry weather, and then often show an orange tinge to the yellow chlorosis, probably as a direct result of sun scorch.

A further development is often seen in a brown or grey scorch which may envelop the tip and margins to the extent of one-third of the leaf area, or even more. This is probably the most significant of the complex of symptoms, as it appears to be associated with a deficiency of potash.

A considerable number of analyses have been carried out but, as an interim report, it will merely be stated that it appears that factors conducive to the accumulation of excessive manganese in the foliage also tend to depress the uptake of potash, even under experimental conditions where up to 180 lb. of K_2O had been applied per acre per annum. In view of the probability that sulphate of ammonia, in conjunction with highly acid soils, is an important factor in aggravating manganese toxicity, it will be seen that we are justified in attaching priority to the elucidation of these problems.

The chlorosis is familiar to superintendents in the low-country and in Uva, and many causes have been assigned to it. It had been tentatively described as "low-country chlorosis" in the Annual Report of this Division for 1954, which term can now be superseded by the description "manganese-toxicity chlorosis". Severely chlorotic leaves have been analysed to show a manganese content of 3,500 to 4,100 p.p.m. of Mn in dry matter.

Less chlorotic leaves, taken during the monsoon, from another district and from a field which was noted for the severity of chlorosis and scorching during dry periods, when analysed gave 8,000 p.p.m. of manganese.

In both areas black manganese-oxide deposits were found coating gravel and stones at varying depths in the soil, and similar deposits are a familiar feature in many road banks.

Fortunately we have several experimental areas available in appropriate districts and also the requisite staff to carry out detailed experiments within them. It may be noted that the highest manganese contents yet found in many soil analyses, 100 to 400 p.p.m. of reducible Mn, were determined on profile samples from one area in the Endane manurial trial.

4. **Potassium.**—From the proceeding notes it will be seen that attention has been focussed on potash once again. Several years ago, potash deficiency could be attributed without doubt to the depletion of soil reserves following inadequate replacement of potash in the routine manures. It subsequently appeared that a mixture such as the standard manure, T. 500 or 488, was sufficient to maintain potash requirements.

From observations in the field, supported by analyses from controlled field experiments, we have recently become aware that actual response to potash may differ widely from that expected from the quantity of potash applied in the manure. Further, there may be little point in increasing potash applications, except possibly by means of foliage sprays, until the antagonistic soil conditions have been rectified.

Classification of visual symptoms of potash deficiency on leaves from the K.0 plots in the No. 3 Field N.P.K. Experiment showed that there were four groups of patterns:

1. grey scorch at tips and/or margins;
2. brown scorch;
3. dull yellow chlorosis at tips and margins, extending between the main veins and developing brown tinges;
4. heavy purplish-brown or dark purple mottle at tips and margins, extending deeply into the leaf.

A start has been made on analysis of leaves from these groups, in relation to the stage of the cycle and in particular to the balance of other nutrients, *viz.* calcium and magnesium. No symptoms were visible at the end of 1959, although at least one known area of severe deficiency had been pruned as early as July 26th.

The fourth symptom observed on the above experiment was the least common there, but was observed plentifully in different districts, and in such diverse sites as a high-manganese field and an area where tea bushes and limestone boulders alternated. This symptom may prove to represent a compound nutritional disorder. An approximation to the first symptom, a grey edge scorch, was observed on a low-country estate where drought effects and red rust were associated with debilitated bushes. Here, however, the scorching was concentrated at the tips of the leaf serrations instead of the more usual uniform marginal scorch. There would appear to be useful practical applications to be obtained from a fundamental study of the deficiency symptoms available on the St Coombs experiment, and together with the manganese-toxicity problem, potassium deficiency will occupy a large place in the future of the plant-nutrition research programme, with particular reference to our

oft-repeated warning that high levels of manuring may bring their own problems unless we are able to anticipate changes in soil conditions and modify manurial practices accordingly.

C.—GENERAL

A recording rain gauge was installed on Pedro Estate, Nuwara Eliya, and soil thermographs continued to be operated on Pedro, Kirimetiya (Galaha), Gonakelle (Passara) and Endane Estates, as well as on St Coombs. To all the Superintendents concerned we offer our thanks for their co-operation in supplying these much needed long-term data.

D.—TRENDS IN CULTIVATION AND MANURE APPLICATION

An attempt was made to collect together our ideas on the principles underlying the practice of cultivation and to examine the relation, if any, between these operations and the actual application of manure, and the result appeared in an issue of the *Tea Quarterly*. It is hoped that the separation of cultivation from manure application will be accepted, whenever necessary, according to the principles involved, as otherwise we feel that undesirable trends in practice may develop.

E.—SOIL REHABILITATION

Attempts have also been made to halt a tendency to disregard the need for soil rehabilitation when uprooting old tea. It was not possible to carry out detailed work on this subject, but a few illustrative analytical results were reported in the *Tea Quarterly* and may serve to direct attention to the value of Guatemala grass roots in improving soil conditions for the establishment of the young tea.

E.—PUBLICATIONS

Tolhurst, J.A.H. (1959). General principles of soil cultivation and of methods of manure application to tea. *Tea Quart.* **30**: 19–29.

Tolhurst, J.A.H. (1959). Revised suggestions for dolomite and magnesium applications to tea. *Tea Quart.* **30**: 48–49.

Tolhurst, J.A.H. (1959). Guatemala grass roots in soil rehabilitation. *Tea Quart.* **30**: 117–120.

REPORT ON BIOCHEMISTRY FOR 1959

M. S. Ramaswamy, B.Sc., A.R.I.C., A.I.Sc.

General.—The renovation of the biochemistry wing of the Chemistry Division was begun in August 1959, and should be finished early in 1960. The work is being done in stages so as to minimize interference with research, but there have naturally been some difficulties.

Meetings.—I attended five meetings of the Liaison Committee of the Board of the Tea Research Institute on "Instant Tea", four of them in Colombo.

Research.—During 1958 the policy was to associate biochemical work closely with the manufacture of tea rather than with the growing leaf and the following programme of investigations for 1959 was drawn up by the then Director, the Technologist, the Acting Biochemist, and myself:—

1. the volatile substances in dried green leaf and in manufactured tea from various estates at different elevations and climatic conditions;

2. correlation between chemical analysis and liquoring properties of brewed liquors from teas manufactured at different elevations and climatic conditions;

3. tea enzymes (polyphenol oxidase and pectin methyl esterase):—

   (*a*) effect of minor elements applied to soil;
   (*b*) effect of copper fungicides (sprayed during the wet season only);
   (*c*) effect of shade;

4. chlorophyll in flush and maintenance leaf:—

   (*a*) effect of minor elements;
   (*b*) effect of copper fungicides (sprayed during the wet season only);
   (*c*) effect of different manurial treatments.

1. **The volatile substances in tea.**—With a view to finding out the variations in the volatile substances in Ceylon green leaf (dried) and in manufactured tea from different elevations and climatic conditions, as a preliminary to further fractionation and identification of the constituents, regular samples were obtained every month for one year from various estates. We wish to record, once again, our gratitude to the Superintendents of all these estates for their very kind co-operation in supplying the material. As reported in the Annual Report for 1958 (p. 45), a broad distinction was made between the free volatile matter, which consists of all organic substances volatile in steam, and the hydrolysable volatile matter, which consists of methyl alcohol derived mostly from the water-soluble pectic substances. The results were statistically analysed and the following tentative conclusions were arrived at:

A. Green leaf.—(*a*) Free volatile substances increased during the dry season in the S.W. monsoon zone, but they decreased in the N.E. monsoon zone (Uva). The results were, however, not statistically significant.

(*b*) Hydrolysable volatile substances increased significantly during the dry season in the S.W. monsoon zone, but they decreased in the N.E. monsoon zone (Uva).

B. Black tea.—(*a*) Free volatile substances increased significantly during the dry season in the S.W. monsoon zone, but they decreased (not significantly) in the N.E. monsoon zone.

(*b*) Hydrolysable volatile substances increased significantly during the dry season in the S.W. monsoon zone, but they decreased (not significantly) in the N.E. monsoon zone.

It therefore appears that we have as yet no indication of the biochemical nature of Uva flavour; on the other hand, there is a preliminary indication that up-country flavour may be due to free volatiles, possibly influenced by hydrolysable volatiles as well.

The dried green-leaf samples obtained from various estates represented the mixed bulk from the supply of green leaf to the factory. It was therefore decided to carry out the investigation on clonal leaf as well. For this purpose, clone TRI 4 from St Coombs was used, because a regular large supply of this leaf was available. Only one sample was obtained in the months of May and July 1958, but 2 to 4 samples a month were obtained from September 1958 to October 1959, 39 samples in all. The results were compared with the meteorological data for the 24 hours before the plucking date. As already indicated in the report for 1958, the hydrolysable volatile substances (representing mostly the water-soluble pectic substances) showed an approximate relationship with the difference between the maximum and minimum air temperature. It was found that the free volatile substances also showed a similar trend.

2. **Correlation between chemical analysis of the liquors and the liquoring properties of teas manufactured at different elevations and climatic conditions.**—Investigations so far carried out in different tea-producing countries have generally been confined to relating the taster's valuation (in terms of the market value) with the analysis of black tea as a whole. This procedure is somewhat unrealistic because the liquors obtained by a five-minute brew do not contain everything that is in the black tea; there is a further complication, in that the tasters' valuations of the liquors (in terms of the market value) also cover the valuation of each tea for its grade, appearance and the prevailing market demand. It was, therefore, decided to investigate the constituents of the tea liquors obtained by a five-minute infusion and to relate the results to the tasters' valuation, on the basis of marks, for the various liquoring properties, ignoring the valuation for grade, appearance, etc. We wish to acknowledge gratefully the help of several tasters in Colombo who kindly assisted us in this investigation. We also wish to record our gratitude to the Superintendents of various estates who provided us with the samples of black tea. It should be mentioned here that work on these lines is also being carried out by the Indian Tea Association.

The investigation is still in progress and the results are expected to be ready early in 1960, when a statistical evaluation will be made. Certain tentative conclusions may, however, be drawn from the results obtained so far.

A fairly consistent relationship appeared to exist between theaflavin content of liquor and the tasters' valuation for infusion, quality and character. The theaflavin content of a tea, in turn, appeared to be directly related to the elevation of the producing area, both in S.W. and N.E. monsoon zones. The correlations between various other characteristics of the liquors were found to be not so marked.

The following additional results of the investigation may be of interest:—

(i) the total soluble matter in the five-minute brew from teas produced during the dry season in both S.W. and N.E. monsoon zones was found to be higher than in teas produced during the wet season;

(ii) the amount of oxidisable matter (total as well as acid-soluble) appeared to be directly related to the elevation;

(iii) the amount of mineral constituents of the liquors from teas produced during the wet season was found to be higher than from those produced during the dry season;

(iv) as reported in the Annual Report for 1949 (p. 28), where it was shown that the total ash-content of the tea was inversely related to the elevation, the ash-content of the liquors, too, was found to be inversely related to the elevation in the S.W. monsoon zone.

3. **Tea enzymes (polyphenol oxidase & pectin methyl esterase).**— **(a) Effect of minor elements.**—In view of the continual depletion of inorganic micro-nutrients from tea soils, investigations were undertaken on the effect, if any, of the application of a number of minor elements to the soil on the polyphenol oxidase and pectin methyl esterase activities in the flush. A small clonal plot consisting of a single clone (TRI 1114) was chosen for the investigation. During the year, four applications of minor elements were made and similar numbers of samples of flush were analysed. So far no effects have been detected and the experiment is continuing. The minor elements were applied in copper sulphate ($CuSO_4.7H_2O$), borax ($Na_2B_4O_7.10H_2O$), zinc sulphate ($ZnSO_4.7H_2O$), and potassium dichromate ($K_2Cr_2O_7$) at half an ounce per bush, manganese sulphate ($Mn\ SO_4.4H_2O$) at one ounce per bush and magnesium sulphate ($MgSO_4.7H_2O$) at two ounces per bush.

(b) Effect of spraying with copper fungicides, etc.—The material for this work was obtained from the protected and un-protected plots in Field No. 8 (St Coombs), formerly used by the Pathology Division for blister-blight experiments. One plot has never been sprayed; the other has received regular applications of copper fungicides during the wet season.

Leaf material was also obtained from four different clones in Field No. 8 (St. Coombs) which were sprayed every week with a mixture of copper fungicides and magnesium sulphate (spraying fluid containing 0.5% $MgSO_4.7H_2O$ + 0.5% *Blitox*) from 25th February 1957 to 15th September 1958. The clonal rows were then divided into halves, one of which continued to receive the mixture for a further period of 4 months from 15th September 1958 to 19th January 1959, while the other was left as control. For a further period of 3 months, from 19th January 1959 to 9th March 1959, the treated bushes received only the copper fungicides at one-fifth of the normal dosage. Spraying with the copper fungicides was stopped from 9th March 1959, when the dry season set in.

There were no significant differences in the polyphenol oxidase and pectin methyl esterase activities of the flush between the untreated and treated plots when copper fungicide alone was used. On the other hand, all the four clones treated with a mixture of copper fungicide and magnesium sulphate showed a slight decrease of the polyphenol oxidase activity over the control.

(c) Effect of shade.—The material was obtained from the protected and unprotected plots in Field No. 8 (St Coombs). The samples for shaded areas were drawn from the bushes around the shade trees. There was a slight increase in the polyphenol oxidase and a decrease in the pectin methyl esterase activity of the shaded bushes compared with the unshaded ones. Leaf obtained from Pedro estate during the severe drought period, however, showed an increase in the polyphenol oxidase activity in the flush plucked from unshaded areas.

4. **Chlorophyll.**—The flush samples obtained for the investigation on tea enzymes were also used for the determination of chlorophylls *a* and *b*. Maintenance leaves were also, in some cases, analysed for the two chlorophylls. The ratio of chlorophyll *a* to chlorophyll *b* was not appreciably affected in any of the samples analysed. The following results obtained may be of interest.

(a) Flush.—The total chlorophyll content of leaf from shaded areas were found to be more than that from the unshaded areas (St Coombs and Pedro Estates).

(b) Maintenance leaf.—The maintenance leaves from clonal rows that had been treated with a mixture of copper fungicide and magnesium sulphate generally showed a pronounced increase of chlorophyll over the control. The leaf from low-jat bushes showed a higher chlorophyll content than the high-jat leaf irrespective of the different manurial treatments. The chlorophyll content of the leaf showed a highly significant inverse relationship ($r=0.7335$, $t=4.0360$, t @ 1% probability $=2.977$) with treatment with phosphatic fertilisers. The effect may be due either to phosphorus or to the calcium present in the fertiliser.

5. **Effect of ultra-violet radiation on chlorophyll.**—The chlorophyll from tea leaves was extracted with 85% acetone, taken up in ether, and washed free from acetone. The solution of the chlorophyll in ether was exposed to ultra-violet radiation from a mercury-vapour lamp at different distances from 2 to 36 inches. Solution kept at a distance of 2″ showed a loss of 62–66% of the total chlorophyll when exposed for $5\frac{1}{2}$ hours.

6. **Instant tea.**—Preliminary investigations were carried out in connection with the 'bitter' or 'metallic' characteristics encountered in instant teas and Clivemeare-rolled teas, the results of which were reported in detail to the Liaison Committee of the Board of the Tea Research Institute on "Instant Tea".

7. **Miscellaneous.**—**(a) Japanese tea.**—Liquors obtained after 5 minutes infusion of black tea from the Agricultural Experimental Station in the Aichi Prefecture of Japan (received by the kindness of the Japanese Embassy in Ceylon) were analysed for purposes of comparison with Ceylon teas. The results given in Table 1 may be of interest. The reports on infusion and liquor were provided by the Technologist.

TABLE 1.—*Analysis of tea liquors*

Constituents	JAPANESE TEA		CEYLON TEA
	Sample No. 1 Natural wither, manufactured on 11-5-1959 (Hatsumamji)	Sample No. 2 Artificial wither, manufactured on 12-5-1959 (Benicomale)	Low-Country Averages of 32 samples from 2 different estates
Total soluble solids	26.8	25.8	27.6
Ash % soluble solids	13.9	12.6	12.3
Total oxidisable matter as % soluble solids	48.9	42.6	46.4
Acid soluble oxidisable matter as % soluble solids	42.5	36.4	36.4
Free volatile substances as decinormal dichromate in 100 g. dry tea	17.8	27.4	14.9
Hydrolysable volatile substances as decinormal dichromate in 100 g. dry tea	8.2	8.2	7.1
Colour as % absorption in photoelectric colorimeter (Spekkar, 1 cm. cell)	51.5	47.9	54.4
Theaflavin as % dry tea ...	1.09	0.59	0.44
Infusion	Bright	Dull	—
Liquor	Good-normal	Light	—

Only the theaflavin content of the Japanese tea from natural wither approached anywhere near the theaflavin content of up-country Ceylon teas, which is generally of the order of 1–1.5%. This is presumably due to differences in the manufacturing technique.

(b) Minor elements—Boron.—The question of possible boron deficiency in Ceylon teas was raised as early as in 1941, when Bond (1941) showed experimentally that Phloem Necrosis is not caused by its deficiency. The following analyses for boron in clonal leaf (St Coombs) carried out some years ago (1954) are given for purposes of record:—

TABLE 2.—*Boron content of clonal leaf*

Clone No.	Boron (p.p.m. dry wt.)
TRI 2043	13.0
KPW	17.5
TRI 960	16.8
TRI 777	17.8
TRI 34	17.8
TRI 2016	17.4
TRI 2025	7.4
TRI 1294	13.3

Publications

RAMASWAMY, M. S. (1959). Pectic substances in Ceylon Tea. *Tea Quart.* **30:** 86–92.

References

BOND, T. E. T. (1941). Phloem Necrosis. Report of the Mycologist for 1941. *Bull. Tea Res. Inst. Ceylon,* no. **23:** 34–42.

REPORT OF THE ENTOMOLOGIST FOR 1959

J. E. Cranham, B.A., D.I.C.

A. **General.**—I assumed duties in Ceylon on 23rd April 1959, having joined the staff of the Institute on 16th January and spent the intervening period at the Commonwealth Institute of Entomology (London), Imperial College Field Station (Silwood Park), and East Malling Research Station (Kent).

Mr D. Calnaido, Research Assistant, left for the U.K. on 15th April for three years further training at Rothamsted Experimental Station. No other changes in staff occurred.

Altogether 341 letters were received and 365 letters sent out, while 136 consignments of specimens were received for advisory work. Estate visits numbering 108 were made by staff, twelve of a purely advisory nature. A meeting of the Mite Consultative Committee was held on 11th November.

B. **Advisory Work.**—The following points are considered to be of notable importance:—

1. **Nettle Grubs.**—Thirty-five outbreaks of nettle grub were reported, mostly in Uva and mostly concerning the Fringed Nettle Grub (*Natada nararia* Mo.). Serious attacks were also seen in Dolosbage. There is little doubt that the Nettle Grub is the most serious caterpillar pest at the present time.

2. **White Grubs.**—Damage by these larvae of cockchafers to the roots of nursery plants and of young tea is sufficiently common to cause some concern, especially in view of the replanting scheme. Eleven cases of damage were reported, chiefly in Hewaheta, Uda Pussellawa, Pussellawa, and Kandapola districts.

3. **Tea Tortrix.**—Sixteen outbreaks of Tea Tortrix (*Homona coffearia* Nietn.) were reported during the year. Seven of these followed the use of dieldrin for shot-hole-borer control as a post-pruning spray. The remaining group of nine outbreaks, which had nothing to do with the effects of dieldrin, is one of the highest figures for Tortrix since the introduction of the parasite *Macrocentrus* in 1935–36. There is no definite evidence that the parasite is becoming less efficient; fluctuations in the degree of control are rather to be expected. The parasite has almost invariably resumed control in a few months. Work on this aspect is planned.

4. **Mites.**—Tea Red Spider Mite was reported from fifteen estates, mostly in Uva and Kandy districts, as against Scarlet Mite five times, Yellow Mite eight and Purple Mite once. Whilst these figures do not indicate relative importance, Red Spider Mite would appear to be a more important pest in the above districts than was previously appreciated.

C. **Mites.**—1. **Method of assessment.**—Work on tea mites in Ceylon has in the past been limited by the techniques used for assessing mite numbers. Considerable attention has therefore been devoted to this aspect, and work was begun on a technique using a rotary brushing machine. This consists essentially of an electrically-driven brushing device which brushes the mites off the leaves on to a revolving circular plate, five inches in diameter, which is smeared with a suitable viscous medium to trap the mites and eggs. The plates can be stored for some time. First results suggest that this method will be applicable to all four mite species and will make counting easier and more accurate.

Studies were also begun on mite distribution on foliage and on sampling methods, for use in acaricidal field trials and in studying the population dynamics of the mites.

2. **Chemical control.**—Preparation has been made for studying the action of various acaricides on tea mites, including the attributes of specific toxicity, persistence, toxicity to eggs and also to active stages, and leaf penetration properties. This work involves laboratory as well as field studies, and certain laboratory facilities are being improved.

Attention has also been given to the vital problem of obtaining good spray-coverage on mature tea. One technique for studying spray-coverage involves the use of fluorescent dyes in the spray material; deposits are then shown up in ultra-violet light. Materials for this technique have been obtained.

Progress on individual field trials was as follows:—

(i) No. 13 Field, St Coombs.—This long-term randomized-block trial (six replicates) started in 1956 will shortly complete a four-year pruning cycle, having been assessed periodically for mite numbers and weight of crop, and a full report will be given on this period in due course. It is most notable that, so far, no loss of crop due to Scarlet Mite damage has occurred on the untreated control plots. It is apparent that bushes will stand very considerable defoliation without loss of productivity in the pruning cycle. Nevertheless the Scarlet Mite causes chronic damage, as shown by the spindly debilitated bushes, which must in time be reflected in loss of crop.

(ii) Gouravilla Estate.—The scarlet-mite trial commenced in 1957, rather similar to No. 13 St Coombs, had to be abandoned in May 1959 because the mite numbers had remained extremely low.

(iii) Kowlahena Estate.—Two trials on the chemical control of Yellow Mite on an area of young tea (clones K145 and K150) have demonstrated that Kelthane and Endrin show promise for the control of this species; sulphur is at present recommended, but it taints badly. No practical recommendations can be made yet.

(iv) Hakgalla Estate.—A full-scale taint test was carried out on the acaricide Kelthane. No taint was detected in made tea made from leaf plucked after the normal seven-day interval.

(v) Lindoola Estate.—Certain fields on this estate were dusted with 4% Karathane dust, four rounds, using a powered knapsack duster. Counts of Scarlet Mite on treated and untreated areas, before and after spraying, showed a reasonable control except on areas of very steep slope, where it proved impossible to give adequate coverage.

(vi) Ambawela Estate.—In a small-scale replicated trial on chemical control of Tea Red Spider, Chlorobenzilate (Akar 338), Aramite, Karathane and Kelthane as well as sulphur all showed some promise, but work is required on methods of assessment before further trials can be made.

3. **Effect of copper fungicides on mite numbers.**—Two replicated field-trials were begun to investigate the possible effect of copper fungicides on mite numbers and increase, one trial on Scarlet Mite at St Coombs, and one on Yellow Mite at Ferham Estate. Treatments included proprietary copper oxide and copper oxychloride wettable powders, Bordeaux mixture, a proprietary colloidal copper, Captan as an alternative fungicide, and untreated controls. Mite numbers have remained very low until the end of 1959, and no differences have appeared yet.

4. **Cultural Factors.**—(i) Clones.—Observations on incidence of and damage by Scarlet Mite on fourteen of the clones at St Coombs showed no appreciable difference in susceptibility between these clones.

Clones TRI 777, TRI 1526, TRI 23, Sheen and Craighead 13 appeared to be more susceptible than average to Yellow Mite.

(ii) Light versus clean pruning.—An important factor in the carry-over of mites, particularly Scarlet Mite, at pruning time may be the type of pruning practised. A trial of randomized block design has been set out on No. 10 Field, St Coombs, to investigate this point.

(iii) Re-infestation by Scarlet Mite from shade trees.—On St Clair Estate, two adjacent areas, of two acres each, have recently been pruned and sulphur-sprayed. One area has *Grevillea* trees infested with Scarlet Mites, the other no *Grevillea* trees. Observations are being carried out to try to assess the importance of falling infested *Grevillea* leaves on the build up of Scarlet Mite after pruning.

5. **Biological control.**—Visitors to the Institute during the year included Dr F. J. Simmonds, Director of the Commonwealth Institute for Biological Control, in July, and Dr V. P. Rao, Chief of the Sub-station of that Institute in Bangalore, India, in December. The C.I.B.C. is working on the possible biological control of tea mites in India and Ceylon, and the Tea Research Institute of Ceylon has made a grant towards this work.

Meanwhile, investigation of the predators of tea mites in Ceylon has been started. The following predators of Tea Red Spider were found and identified by the Commonwealth Institute of Entomology: a staphylinid beetle (genus near *Oligota*); a coccinellid, *Stethorus gilvifrons* (Muls.); an anthocorid, *Bilia* sp. nr. *fracta* Distant. Of these, *Stethorus* was the most voracious predator. A collection of mites of a predatory type, associated with Red Spider and Scarlet Mite, has been sent for identification.

A list of recorded parasites and predators of insect pests of tea and associated green crops was prepared by E. F. W. Fernando. The Commonwealth Institute for Biological Control has also agreed to investigate the possibility of biological control for Shot-hole Borer.

D. **White Grubs.**—The field trial on chemical control at Liddesdale Estate was completed, but the numbers of white grubs have been extremely low and no conclusions are possible.

Treatments with aldrin, dieldrin, chordane and lindane were applied at Mooloya Estate, Hewaheta, and assessment of results will follow.

An extremely heavy infestation was seen at High Forest Estate, Kandapola, late in December, which aldrin had apparently failed to control; a trial is planned. Little is known about the bionomics of the different species involved, and no progress on this aspect was possible in 1959. Experience in chemical control with aldrin and dieldrin in many parts of the world suggests that they should be highly effective, but a few surprising failures have been reported here, and this urgently requires investigation.

E. **Nettle Grubs.**—1. **Wilt disease.**—A small plot trial was carried out at Rosett Division, Demodera, during August-October in order to ascertain the possible practical value of spraying a suspension in blood albumen of the granulosis virus causing wilt disease. Suspensions made from two, three and five diseased larvae were each sprayed over thirty bushes, and comparisons made with untreated plots. Wilt disease caused a high mortality on treated plots within three weeks, and reduced the damage caused by Nettle Grub considerably. No effect was apparent on the next generation of Nettle Grub, which started two months after the start of the experiment.

2. **Chemical control.**—As a result of reports that 1% Teepol had not proved effective in controlling Nettle Grubs, a trial was carried out at Nayabedde Estate comparing DDT, Malathion, and Teepol. 1% Teepol gave virtually no control. DDT (0.1%) and 0.1% Malathion, both in emulsion form, and 0.2% DDT, as wettable powder, gave good control. It is hoped to finalise a recommendation shortly.

F. **Insecticidal residue work.**—With the collaboration of the Tropical Products Institute, London, in carrying out chemical analyses, work on residues of DDT that may occur in green leaf and made tea was started. Complete data are not yet available.

G. **Publications.**—The following paper was published:—

Calnaido, D. (1959). Notes on the distribution and biology of the Lygus Bug (*Lygus viridanus* Motsch.). *Tea Quart.* **30:** 108—112.

REPORT OF THE ENTOMOLOGIST (SPECIAL RESEARCH ON SHOT-HOLE BORER) FOR 1959

E. Judenko, Ph.D.

1. **General.**—As before, the team consisted of an Assistant, four Field Attendants, a Driver, and myself.

The laboratory was still at Millawitiya Estate, near Ratnapura, but the work on Shot-hole Borer (*Xyleborus fornicatus* Eich.) was conducted at various other estates in the low country and the mid-country, about 250 days being spent away from Millawitiya.

2. **Dieldrin spraying of the basal parts of tea bushes.**—**(a) Influence on the adults of shot-hole borer.**—Only small scale experiments were done. The lay-out and details have been described already (Judenko, 1958a, 1959) and once more a dieldrin formulation which contains certain resins was used. For the protection of operators handling dieldrin, in addition to those precautions described previously (Judenko, 1958a), in accordance with the recommendations of the Planters' Association Estates' Health Scheme in Colombo, the operators wore rubber boots.

The expression *dry conditions*, which is used below, means conditions in which the woody parts of tea bushes were dry just before the beginning of spraying.

TABLE 1.—*Dieldrin spraying of tea in plucking; the data on the left are calculated on a basis of one acre with about* 2,500 *bushes*

Dieldrin lb. per acre	Cost of dieldrin in Rs.	Amount of of liquid gal.	Results
5.5	120	110	Considerable reduction in numbers of beetles at 14, 15 and 18 months after a single spraying. In one of the experiments, examination at 25 months after a single spraying showed that the reduction in number of beetles was still rather high. In all experiments rain fell on the day of spraying but not more than 0.5″.
2.8	60	110	When spraying was done in dry weather conditions, there were generally considerable reductions in numbers of beetles at 5, 6 and 8 months after a single spraying, and the results did not differ much from those obtained with 5.5 lb. per acre. When spraying was done in wet conditions, the reduction in number of beetles was low.
1.3	28	110	When a single spraying was done in dry conditions, considerable reductions in numbers of beetles appeared at 5, 6 and 7 months and the results did not differ much from those obtained with 2.8 lb. per acre applied in dry conditions, and from 5.5 lb. per acre. When the spraying was done in wet conditions, the reduction in numbers of beetles was low.

Conclusions.—(i) An average dosage of about 1.3 lb. of active ingredient of dieldrin per acre, the lowest of the dosages mentioned, caused considerable reductions in numbers of beetles at 5, 6 and 7 months after a single spraying, provided the spraying was done in dry conditions. (ii) No practical recommendations emerge from the experiments described.

(b) Influence on the taint and liquoring properties of the manufactured tea.—In September 1959 a large-scale experiment was done at Dickwella Estate, when tea bushes of an average height of 32″ (maximum 46″, minimum 19″) were sprayed at a height of 12″ above ground level with 1.1 lb. of active ingredient of dieldrin per acre (2,500 bushes); 105 gallons of solution were used per acre. Spraying was done by labourers under the supervision of kanganies (foremen). The bush frames were dry and no rain fell between the time of spraying and the time of plucking on the next day. The plucked leaf was manufactured by the Technologist of the Tea Research Institute who reported that the made tea was free from taint, and showed no difference from the control as regards liquoring properties.

No practical recommendations emerge from the experiment described.

3. **Spraying of insecticides on the soil surface of tea land.**—As laboratory experiments had indicated that Shot-hole Borers occasionally come into contact with the soil surface, some small-scale experiments were started by spraying the soil surface of tea land with aldrin, dieldrin, chlordane and Gammexane. All of the experiments were done on tea in plucking and, because it was practically impossible to spray the soil surface only, the lower parts of the bushes, up to 2″–4″ above ground level, were also sprayed. The best results were obtained with dieldrin, and they are given in Table 2.

In all of the experiments, except No. 21/59 (when merely the soil close to the tea bushes was sprayed), the whole surface of the experimental plot was sprayed. Except for Nos. 3/59 and 21/59, the soil surface and the lower parts of the bushes were dry just before the beginning of spraying. As usual, the dosage is given as pounds of active ingredient (dieldrin) per acre.

TABLE 2.—*Effects on shot-hole-borer infestations of spraying the surface of the soil under the bushes with dieldrin*

Experiment No.	Estate	Dieldrin lb. per acre	Date of spraying	Examined: days after spraying	% reduction of beetles inside the branches of tea plants
1/59	Vogan	3.5	3.1.59	111	13
15/58	Niriella	2.9	16.2.58	135	20
5/59	Bandarapola	2.0	22.1.50	141	37
3/59	Oodewella	3.1	13.1.59	64	50
21/59	Dickwella	2.2	23.7.59	125	55
4/59	Hantane	2.8	20.1.59	133	70
3/59	Oodewella	3.1	13.1.59	136	89

CONCLUSIONS.—(i) The results were not consistent; spraying the soil surface with dieldrin sometimes gave satisfactory results in reduction of beetles but at other times it did not.

(ii) It may be desirable to do more trials, in the hope that spray on the soil would have a less adverse effect on *Macrocentrus* (the effective parasite of Tea Tortrix) than spray on the frame of the bush does; the risk of contaminating the plucking table might also be less if only the soil is intentionally sprayed.

(iii) No practical recommendations emerge from these experiments.

4. **Occurrence of Shot-hole Borer in some tea clones.**—Some clones growing at elevations of 400–3,800 ft. were examined in 1959 (cf. Judenko, 1958b), according to the standard unit method (Judenko, 1958). The following T.R.I. clones were examined (figures in brackets give the numbers of estates at which examinations were done): TRI 25 (1), 1526 (1), 2016 (1), 2022 (1), 2023 (6), 2024 (7), 2025 (3), 2026 (6).

Only clone TRI 2026, which was growing in an isolated area of Enselwatte Group, was free from shot-hole-borer infestation. All other TRI clones examined were infested by Shot-hole Borer in various degrees; the lowest infestations occurred in TRI 2023.

Estates' clones numbering 14 were examined on 6 estates; none of them was free from shot-hole-borer infestation.

5. **Investigations on the appearance of the Shot-hole Borer on some of the shade trees growing on tea lands.**—Branches of diameters from about five-sixteenths inch up to one inch were dissected and bark-beetles (Scolytidae) of the approximate size of adult Shot-hole Borer (*Xyleborus fornicatus* Eich.) were collected. The shade trees were kindly identified by Mr J. E. Senaratne, Systematic Botanist, Department of Agriculture, Peradeniya, and the beetles by Professor K. E. Schedl, Federal Forest Research Institute of Austria. The results obtained are given in Table 3. There were no flowers or fruits on the *dadap*, so the species could not be determined.

TABLE 3.—*Average numbers of adult Xyleborus fornicatus* Eich. *per* 100 *yards of branches of certain shade trees*

	Number of estates examined	Total length examined yards	Beetles
Albizzia moluccana Miq. ...	4	228	125
Erythrina sp (*dadap*) ...	3	321	21
Albizzia sumatrana V. Steenis ...	1	75	3
Gliricidia sepium (Jack) Steud ...	4	427	3
Grevillea robusta A. Gunn ...	5	639	1

CONCLUSIONS.—(i) Among the species of shade trees examined, the most heavily infested by *Xyleborus fornicatus* Eich. was *Albizzia moluccana* Miq.

(ii) No evidence was obtained that beetles from the shade trees are able to infest tea plants. Experiments are planned to clear up this point.

References

JUDENKO, E. (1958). Trials with a method of assessment of infestation caused by Shot-hole Borer (*Xyleborus fornicatus* Eich.) on old tea. *Tea Quart.* **29**: 51–59.

JUDENKO, E. (1958a). Preliminary small-scale field experiments on a chemical method for the prevention of shot-hole-borer (*Xyleborus fornicatus* Eich.) attack on tea in plucking. *Tea Quart.* **29**: 115–124.

JUDENKO, E. (1958b). Annual Report of the Entomologist, Special Research, for the year 1957. *Bull. Tea Res. Inst. Ceylon*, no. 39: 57–59.

JUDENKO, E. (1959). Report of the Entomologist, Special Research. *Annu. Rep. Tea Res. Inst. Ceylon for* 1958: 81–82.

REPORT OF THE NEMATOLOGIST FOR 1959

M. T. Hutchinson, Ph.D.

Staff.—I arrived in August and took over duties as head of the Division from Dr T. Visser, Acting Nematologist. Mr R. A. Jayatilleke, Research Assistant, arrived in May with the result that the staff is now complete.

General.—The Division carried out analyses for nematodes (eelworms) on 2,039 experimental and 601 estate samples; 155 letters were received and 151 despatched; 25 visits were made to estates.

Projects.—(a) Resistance and tolerance to the Meadow Nematode, *Pratylenchus coffeae.*—

1. Tests at St Coombs.—These tests were begun in an infested field plot in 1950 and other clones were planted in 1951, 1954 and 1956. Some clones, such as DT 1 and DT 95 had been tested for nematode resistance, yield, and quality, before being included in the programme. Other clones, such as KW 16/3, and CL 19, were selected from uninfested estates on the basis of characteristics other than resistance to nematodes.

There are now 78 clones in the field plots, represented by from 7 to 10 bushes each. However, only 50 of these clones are growing in soil adequately infested with Meadow Nematode. Of these, 36 are in plucking. In late 1955 and early 1956, a total of 69 clones, including 39 of those represented in the field plot, were planted in pots. Ten plants of each clone were used, of which 5 were subsequently infested and 5 were not. The nematodes used in the pot experiment were obtained from Eildon Hall and Diyanilakele estates, whereas those in the field plots were presumably native to St. Coombs.

The field plots were plucked regularly for yield. The pot plants were pruned as necessary and the prunings weighed. Two samplings for nematodes have been made from the field plots (1956 and 1959) and the pots (1958 and 1959). In the field three samples for nematode analysis were taken per row of 7 to 10 bushes. One sample was taken from each plant in the pot experiment.

Table 1.—*Relationship between yield, visual appearance, and infestation with Meadow Nematode. Results from 68 clones in pot tests*

Category and No. of clones	Yield of infested relative to uninfested bushes[2]	Visual appearance[3]	Nematodes per 100 gm. soil[4]
A — 9	110% and above	80	44
B — 11	100 — 110%	78	61
C — 10	90 — 100%	64	87
D — 14	70 — 90%	54	125
E — 14	50 — 70%	50	137
F — 10	30 — 50%[1]	38	173

Notes:—1. Clone M 111 is included, but its relative yield was only 12.6%.
2. Prunings were weighed from both infested and uninfested plants of the same clone. A rating over 100% means that the infested plants produced more prunings than the uninfested plants.
3. Considering 100 as the best rating possible.
4. Average of two samplings, taken about 21 and 26 months after the clones were infested.

The preliminary results of these tests are indicated in Tables 1 to 5, which are derived from unpublished data obtained by Dr T. Visser and Mr M. K. Vythilingam. When clones are grouped according to their ability to yield when infested with Meadow Nematode (Table 1), a definite inverse correlation is evident between bush vigour and nematode infestation. That is to say *as the nematode population increases, both the yield and the general appearance of the bush decrease.* This is a general trend. Within each category there is, however, rather wide variation, due to the fact that some bushes are tolerant in various degrees (yield despite infestation) and others are likewise resistant (unsuitable for the normal development or reproduction of the nematodes).

The 9 clones in Category A of Table 1 showed an increase in weight of prunings *when infested*, ranging from 112 to 157 per cent. This indicates the possibility that the nematodes can actually stimulate the growth of certain clones. Although such stimulation has been reported for Root-knot Nematodes, it has not previously been reported for any of the Meadow Nematodes, so far as I know.

TABLE 2.—*Basic types of clones as regards reaction to infestation with nematodes. Study of* 68 *clones in pot tests*

Resistant—Nematodes cannot develop well[1]
DK8, *DK10, DK17, *DK49, DT95, M7, M17, M18, M111, M208, M214.

Resistant and good yielders—Nematodes cannot develop well[1] *and plant yields well*[2]
DK8, *DK10, *DK49, DT95, M17.

Hyper-sensitive—Nematodes cannot develop well[1], *but plant yields poorly*[3].
M111, M208.

Tolerant—Nematodes develop well[4], *and plant yields well*[2].
*TRI 2148.

Susceptible—Nematodes develop well[4] *and plant yields poorly*[3].
CH 171, *CR13, *DK29, DK53, *DK67, M112, M116, *TRI2024, *TRI2026, TRI2120.

Notes:—1. One-sixth of the average population or less.
2. In the upper one-third when relative yields of infested and uninfested plants of a clone are compared with those of other clones.
3. In the lower one-third when relative yields of infested and uninfested plants of a clone are compared with those of other clones.
4. Twice the average population or more.
* Populations of nematodes declining on second reading or remaining the same. All others increasing.

Table 2 illustrates, by the use of extreme examples, the types of clone with which we find we have been working. The definitions given as to *resistant*, *tolerant* and *susceptible* are easy to understand (Hutchinson, 1960). Hyper-sensitivity, however, is a somewhat more difficult concept. Clone M 111 provides a particularly striking example, as it is tenth in resistance, yet 68th in relative yield. Apparently the activities of the nematodes are so detrimental to the roots of this clone that the nematodes are unable to multiply. A similar phenomenon is seen with *Meloidogyne brevicauda*, the Root-knot Nematode, on the rare occasions when it attacks mature tea. In this case the older roots are greatly swollen and heavily pitted, the pits indicating the former positions of the female nematodes. Few living females can be found,

however, and very few of these contain eggs. Only occasional males or larvae can be dissected from the tissues or obtained from the surrounding soil. The nematodes appear barely able to survive on tea. Nevertheless they cause considerable root injury and a gradual decline of the bushes, a decline comparable to that produced by the Meadow Nematode.

Table 2 also illustrates what may prove to be the adaptation of the nematode population to most of the clones that initially seemed resistant in the pot test. In all but a few cases, the second sampling showed higher populations than the first, indicating that although most of the nematodes could not adapt to the clones *at first*, the survivors were able to do so. From this standpoint, progressive decline of the nematode population is a more valid indication of resistance in a clone than is an initially low but increasing number. Thus, a clone such as TRI 2148, which now appears to be tolerant, may eventually prove to be resistant.

Where the population is decreasing around susceptible clones, it is likely that the roots are dying faster than new ones can be produced.

All clones classed as *resistant* in Table 2, with the exception of DK 8 and DK 17, were re-infested with meadow nematodes in May in order to verify their apparent resistance. At the same time, 6 clones known to be susceptible were re-infested to serve as controls. The nematodes were obtained at St Coombs.

In the field plots, using the same criteria as in Table 2, clones DK 1, DK 16 and TRI 2135 are resistant and DT 95 and GL 48 probably so. Of these, DK 1, DK 16 and GL 48 are also good yielders when compared with the other *infested* clones, since there were no uninfested bushes in the field plots. No clones can be considered either tolerant or hypersensitive using the extreme criteria of Table 2. Clones Q1/5 and TRI 2137 are susceptible. In contrast to the nematode populations in the pots, those in the field are generally declining.

TABLE 3.—*The clones that are highest yielding when infested with Meadow Nematode, given in descending order of yield (preliminary results)*

Clones in field plot[1]	Clones in pots[2]
DA434	K145
DK11	DK16
TRI2142	DK8
DK8	DK14
DK16	KW16/3
K145	DK1
TRI2025	DA434
DK1	DT95

Notes:—1. Selected from 36 clones from which yield data are available (leaf weight).
2. Selected from 68 clones (pruning weight).

Table 3 compares yields of clones in the field with those of infested clones in the pot test. The yields of the latter are also actual, rather than relative to the percentage increase or decrease in yield when infested and uninfested plants of the same clone are compared (as in Table 1). It is of interest that five of the top eight clones are high yielders in both field and pots (DA 434, DK 8, DK 16, K 145, DK 1).

It should be noted here that each population of the Meadow Nematode can be expected to differ from the others and that the St Coombs population (in the field plots) is not the same as the population taken from Eildon Hall

TABLE 4.—*Summary of results with three of the best clones under test at St Coombs*

Clone	High Yield		Resistant		Above average quality
	Pots	Field	Pots	Field	
DK8	×	×	×		×
DK16	×	×		×	×
DT95	×		×	×	×

and Diyanilakele (used to infest the pots). This helps to explain why some clones such as TRI 2135 were highly resistant in the field plots and rather susceptible in the pot tests. Table 4 shows the same principle to a less dramatic degree, where DK 8 is considerably more resistant to the pot population than to the field population, while the reverse is true for DK 16. Clone DT 95, which is resistant to both populations, is perhaps the most promising clone from this standpoint.

The data in Table 5 show that the high-yielding and good-quality clones TRI 2024 and 2025 may differ significantly in their reactions to Meadow Nematode. The former appears to be susceptible and the latter to be rather tolerant.

TABLE 5.—*Comparison of Clones TRI* 2024 *and TRI* 2025 *as regards tolerance to infestation with Meadow Nematode. Preliminary results*

Field plots

Clone	Yield[1] in oz.	Appearance[2]	Nematodes per[3] 100 gm. soil
2024	1.3	20	38
2025	4.1	80	38

Pots

Clone	Yield in oz.[4]		Appearance	Nematodes per[5] 100 gm. soil
	Control	Infested		
2024	11.1	4.2	70	325
2025	8.1	5.9	60	384

Notes:—1. Yield per bush, average of 131 plucks.
2. Appearance of infested compared with uninfested plants; 100 is the best rating possible.
3. Average of two samplings taken approximately 2 and 5 years after the clones were planted in infested soil.
4. Yield per bush, average weight of 3 prunings.
5. Average of two samplings taken approximately 21 and 26 months after the clones were infested.

2. Tests at other estates.—These other tests were begun in 1955 at Dambatenne, Diyanilakele, Kirimetiya and Mooloya estates, and are continuing. Evaluations are being made, but yields are not being recorded. So far, clone K 145 shows excellent growth and DT 95 very good growth in comparison with other clones. Very few Meadow Nematodes can be found around the roots of DT 95, indicating that this clone is resistant to a wide range of Meadow Nematode populations. It should be noted that K 145 also shows excellent growth even though supporting moderate to high numbers of Meadow Nematodes and can be considered highly tolerant. It appears, however, to have below average quality.

3. Laboratory tests.—A method is being developed whereby rooted cuttings are grown in glass dishes in a small amount of soil and infested with Meadow Nematodes. The plants are then divided into groups, and the roots are removed and stained at intervals to determine the progress of the nematodes. The object is to compare the development of the nematodes in roots of a susceptible clone (TRI 2024) with that in roots of resistant clones.

Once we know in what way clones can be resistant, new clones can be initially screened in the laboratory, and those without promise of being resistant can be discarded rather than being included in lengthy field trials.

4. Conclusions.—As a result of many years of selection and testing, there appear to be roughly a dozen clones that are markedly resistant or tolerant to the Meadow Nematode. However, the preliminary nature of this conclusion cannot be stressed too strongly. Reasons for this follow.

i. The clones have been tested against only a few of the Meadow Nematode populations that they can be expected to encounter if they become widely distributed.

ii. At St Coombs, there was insufficient space for replication of clonal rows in the field test.

iii. Further evaluation of all tests is needed.

Tests are being planned to remedy deficiencies 1 and 2. In the mean time, after further evaluation of tests already in progress, we should be in a position to recommend certain clones as likely to succeed in areas infested with Meadow Nematode.

(b) Influence of organic matter on populations of Meadow Nematode.

1. Pot tests.—These were initiated at St Coombs in May, 1959. Five year-old plants of 7 different clones susceptible to the Meadow Nematode were transferred from cans to cement pots, and single plants of each clone were used with the following treatments:

control, infested with Meadow Nematodes;
control, not infested with Meadow Nematodes;
raw cattle manure, 2 lb., infested;
raw cattle manure, 2 lb., not infested;
composted cattle manure, 2 lb., infested;
composted cattle manure, 2 lb., not infested.

The plants noted as "infested" had been infested $3\frac{1}{2}$ years before the experiment began, and counts to determine the population level were made before addition of the manures. The experiment is continuing. Resampling will be done during February and March 1960.

2. Field experiment 1.—An area of about ¼ acre in No. 10 Field, St Coombs, previously in gum trees, is being used to determine the effect of composted weeds and cattle manure on the nematode population and growth of basket plants taken from a heavily infested nursery. The area is divided into four sections; two of these are treated with compost and two of them are not. Four pounds of compost was used in the hole around each plant at time of planting. The experiment began in December and is being done in co-operation with the Superintendent, St Coombs.

3. Other experiments.—An experiment to determine the effect of composted cattle manure on mature tea infested with Meadow Nematodes is under way at Ferham Estate.

(c) **Influence of marigolds on populations of meadow nematode.**—1. Test at St Coombs.—This experiment was begun in June 1958 when basket plants of clone TRI 2024 were set out in a heavily infested area. The following treatments are included: marigold interplanted with tea; soil fumigated with DD mixture before planting tea; tea planted without treatment. Results obtained during 1959 indicate that the marigolds have had a more lasting effect than fumigation in reducing the Meadow Nematode population and in improving plant growth. The experiment is continuing.

2. Test at Great Western Estate.—This experiment, begun in May, was set out to determine the effect of different cover crops, alone and in combination, in reducing the numbers of Meadow Nematodes in old tea soil before replanting tea. The cover crops used were various types of marigolds, Guatemala grass, and *Mimosa invisa*. Sampling for Meadow Nematodes before the beginning of the experiment, compared with sampling in January 1960, shows that no treatment eliminated the Meadow Nematodes, and that marigolds, either alone or in combination with Guatemala Grass, had no greater effect after eight months than did Guatemala Grass alone.

3. Test at Holyrood Estate.—Similar to that at Great Western Estate. To be evaluated in February/March 1960.

4. Other tests.—Experiments have been initiated to determine whether or not Meadow Nematodes will enter roots of marigold seedlings, and at what stage of growth marigolds are the most resistant or toxic to the nematodes.

From experience so far, marigolds might be profitably used for the following purposes:

(i) *As a pre-crop for reconditioning old tea or nursery soils either alone or in combination with Guatemala grass.*—Although the combination does not as yet appear to be any more effective than Guatemala Grass alone in reducing populations of the Meadow Nematode, the marigold grows more rapidly, and thus provides good soil cover before the Guatemala Grass can do so. Marigolds can be grown from seed.

(ii) *As a cover crop in young tea.*—To give protection from soil erosion, and to keep the nematode population low while the plants are becoming established. The marigolds can be seeded several months before planting and the tea planted among the growing marigolds. The marigolds must be kept lopped to avoid shading the tea, and the loppings can then be used as mulch or forked in.

(iii) *To fill vacancies in mature tea before resupplying.*—A one-year reconditioning of vacancies seems practical if the marigold plants are set out from a nursery. Otherwise, the seedlings may become trampled as they germinate. The life of a vigorous type of marigold is about one year, so that the time for supplying is indicated by the death of the marigold plants.

Seed of the tall vigorous marigold varieties is being produced in limited quantities at St Coombs. Samples will be available for estates wishing to establish marigolds.

(d) Survey for the distribution of the Meadow Nematode.—The known distribution of the Meadow Nematode, *Pratylenchus coffeae*, has been mapped with approximately 200 pins of different colours. The result shows clearly that the Dimbula, Dickoya Upper and Hewaheta Upper Districts are the most heavily infested, and correlates well with the injury to tea observed on estates in these districts. Occasional estates in the Haputale, Hewaheta Lower, Maskeliya, and Uda Pussellawa Districts are also heavily infested. Serious injury to tea is thus limited principally to estates in the high country above 4000 ft. elevation.

To determine whether or not estates at lower elevations are actually free of Meadow Nematodes, a careful on-the-spot survey was conducted on 10 estates below 2000 ft. in the Galle, Kalutara, Morawak Korale, Rakwana, and Ratnapura Districts, and on 4 estates from 2000 to 4000 ft. in the Balangoda, Rakwana, and Morawak Korale Districts. The locations selected on each estate were those in which the tea was declining. Of the 14 estates, only 4 had Meadow Nematodes and the numbers were very small. A comparison of the 10 low-country estates with 10 high-country estates from which samples were received during the same period (Table 6) shows clearly the difference in numbers involved.

TABLE 6. *Comparison of numbers of Meadow Nematodes (Pratylenchus coffeae) found at low-country and high-country estates. November* 1959 *to January* 1960. *Each sample contained* 100 *g. of soil.*

Low-country—Below 2,000 feet

District	Estate	Samples total	Meadow Nematodes, total
Galle	A	11	0
	B	7	0
	C	11	3
Kalutara	A	8	1
	B	15	0
	C	13	0
Morawak Korale	A	7	0
Rakwana	A	14	8*
Ratnapura	A	5	0
	B	14	0

*All found in one sample.

High-country—Above 4,000 feet

District	Estate	Samples total	Meadow Nematodes, total
Dimbula	A	7	0
	B	2	3
	C	12	94
Hewaheta Upper	A	6	0
	B	7	386
Maskeliya	A	2	73
	B	5	297
	C	5	0
Nuwara Eliya	A	5	32
Pundaluoya	A	6	0

At present there is no known tea estate in Ceylon, below 2000 ft. elevation, where the Meadow Nematode either multiplies rapidly or causes severe injury; therefore clones resistant to this nematode do not appear to be needed in the low country. Considering the many years that have been available for the spread of the Meadow Nematode to the low country, and the fact that the nematodes are readily carried downstream with silt and rainwater, it seems strange that low-country estates are not heavily infested. The answer may be that the temperatures are too high for proper development of the nematode. If this is the case, it would appear that average temperatures between 70 and 80 degrees Fahrenheit inhibit development.

Two important facts to note are that (1) the Meadow Nematode *does* occur in very small numbers on a few low-country estates, but apparently *does not* multiply rapidly, and (2) there are many estates above 4000 ft. that do *not* have the Meadow Nematode so far as we know. No reason can be proposed for the second fact at the moment, except that these estates may have so far escaped infection.

(e) Importance of other nematodes associated with tea.—1. Root-knot nematodes.—A preliminary check of the roots of clones DT 1 and DT 95 planted in an area infested with the Root-knot Nematode of mature tea, *Meloidogyne brevicauda*, showed that these clones are susceptible. An experiment is under way to determine more precisely the age at which tea plants become resistant to the common Root-knot Nematode, *Meloidogyne javanica*.

2. Spiral nematodes.—At least two different species of spiral nematode have been commonly found around roots of mature tea at all elevations. The species are being identified. There is preliminary evidence that one of these nematodes may be harmful to mature tea, and that both species may multiply on Guatemala grass. Experiments are under way to determine whether or not these species will multiply on or cause injury to tea.

3. Pin nematodes.—At least two different species of pin nematode have been commonly found around roots of mature tea. One species appears to be most abundant in the high country and the other at lower elevations. The species are being identified. An experiment is under way to determine whether or not the high-country species will multiply on or cause injury to tea.

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REPORT OF THE PLANT PATHOLOGIST FOR 1959

D. Mulder, Nat. Phil. Dr

General.—**Staff**—I acted for the Plant Physiologist during his period of home leave from 21st April till 24th July. Mr W. W. Redlich assumed duty as Technical Assistant in January. In May Mr N. Shanmuganathan left for the U.K. on a Colombo Plan Scholarship to study in the University of London, working in the Pathology Division of the East Malling Research Station. In July Mr J. V. Sabanayagam left for Canada on a Colombo Plan Scholarship for training in extension work with special reference to plant diseases at Ontario University. His place as Field Assistant had not been filled by the end of the year. On 25th September Mr U. L. M. de Silva arrived to be trained in plant pathology before going to the low-country as assistant to the Low-country Scientific Adviser at Ratnapura.

I attended the 16th Annual Conference of the Indian Tea Association at Tocklai Experimental Station, Assam, from the 16th to the 10th of November and thereafter visited the Darjeeling district from the 23rd to the 27th November.

Advisory Work.—The total correspondence consisted of 582 letters received (1958, 526) and 782 letters despatched (1958, 508). The outward letters exceeded the inward ones because correspondence regarding experiments is included. The number of visits to estates was 132, including 34 for advisory work. Most superintendents reacted promptly to our note in the *Tea Quarterly* about giving full information regarding diseased specimens. It is, however, most valuable when superintendents, in the accompanying letter, also give their own opinion about the cause of the trouble. The advisory work was handed over to the new Chief Advisory Officer shortly after his arrival in November.

Research.—I. **Parasitic diseases**—1. Blister Blight (*Exobasidium vexans*).

(*a*) *The timing of spraying according to hours of sunshine recorded.*—During the S.W. monsoon the method of basing the necessity for spraying on sunshine records was put to a practical test on a number of estates. With the help of T.R.I. officers, each estate carried out its own experiment. Assessments were done on the estates. Full records were received from Dessford, Meddecombra, Kintyre, Kirimetiya, and St Coombs estates. As Table 1 shows, a considerable number of spraying rounds was saved on each of these estates.

TABLE 1.—*Average infestation of Blister Blight in blocks sprayed (a) according to sunshine data (expt.) and (b) according to normal estate practice (control), with the numbers of spraying rounds saved*

Estate	Average of infection		Average No. of rounds, June to December		No. of rounds saved	Av. sun per day
	Expt.	Control	Expt.	Control		hr. min.
St Coombs ...	19.0%	21.0%	16	26	10	4 2
Dessford ...	18.7%	16.4%	17	20	3	2 26
Meddecombra North	20.8%	12.4%	9	16	7	3 47
Kintyre ...	19.4%	20.0%	12	23	11	4 26
Kirimetiya ...	7.6%	6.1%	6	17	11	5 36

At Dessford Group, Nanuoya, the experiment was modified because the decision to spray or not to spray was taken for a whole division instead of being reached for trial blocks separately on consecutive days. This was therefore a much more severe test of the method but even here the results were favourable, showing that a minimum average of 4 hours daily sunshine over a period of 5 days is still on the high side. At Meddecombra, results in the experimental blocks were less good than in the control block sprayed by the estate. This was not, however, due to the saving of spraying rounds but to the fact that the estate sprayed on 7-day rounds, compared with 10-day rounds in the experiment. We are now satisfied that economies in blister-blight spraying can be achieved, by estates using sunshine records for forecasting; we would, however, recommend in addition that an estate that tends to have different weather conditions within its boundaries should cover this by having two or more sunshine recorders, suitably placed. Our thanks are due to superintendents who supplied us so readily with the results of their experiments.

(*b*) *Fungicides.*—With a view to introducing other fungicides and avoiding eventual copper toxicity of the soil (Tolhurst, 1959) several new carbamates were compared with some standard copper fungicides. Definite proof was obtained, however, that this group of fungicides is not suitable for blister-blight control.

Other possibilities for the reduction of the amount of copper used in spraying are to introduce mixed copper-zinc fungicides and colloidal coppers (15% Cu). These will be tried in the next monsoon.

(*c*) *Stickers.*—During the severe S.W. monsoon a trial was conducted of the effectiveness of three different stickers, for adding to fungicides. No benefit of the addition of a sticker to 3 oz. of a copper oxychloride per acre was found. Stickers are useful in other crops but have no appreciable influence on the control of Blister Blight in tea; the regular removal of those parts of the plant that are both sprayed and susceptible makes high retention of the copper a useless characteristic. In any case, copper oxychloride on its own has already a sticking capacity which lasts long enough for protection during the ordinary length of spraying round. Therefore in our next (and possibly last) sticker trial, we shall try a further reduction in the amount of copper and a lengthening of the interval between sprayings in order to bring out the slightest advantage of stickers. Since some planters are still using stickers we shall also test their effects on valuations of made tea.

2. Root-diseases.—The cost of eradicating *Poria* root disease is high; any measure would be welcome that would help to reduce its spread and to simplify its eradication. So far eradication by sifting the soil and removing all infective material seems to be the only thing to do. Recent attempts to replace this method by soil fumigation with D.D. have, in our opinion, little prospect of success; it is already known from the literature that failure has resulted from attempts to kill fungi like *Fusarium, Sclerotinia* and *Verticillium,* which have less resistant forms of mycelium and fructification bodies and which penetrate the plant tissues to a smaller depth.

A reduction of the spread of *Poria* by cultural measures might be more within our reach. It is well known that certain saprophytic fungi exert an inhibiting effect on the growth of parasitic fungi in the soil. One of these growth inhibitors is *Trichoderma viride.* The influence of the metabolic products of this fungus has been tested *in vitro* on mycelial growth of *Poria.* Preliminary results so far indicate that *Trichoderma* has a marked effect on *Poria* growth (Table 2).

Table 2.—*Effect of inoculating the soil fungus Trichoderma viride Pers. on the fungus Poria hypolateritia Berk. in clay, sand, and loam soil columns.*

The figures give the lengths reached, in millimetres.

Number of days after inoculation	CLAY SOIL		SANDY SOIL		LOAMY SOIL	
	Poria & *Trichoderma*	*Poria* only	*Poria* & *Trichoderma*	*Poria* only	*Trichoderma* & *Poria*	*Poria* only
11	10	19.3	20.8	60.0	12.0	17.6
13	23	108.6	36.0	65.3	22.5	65.0
15	40	114.3	36.0	74.0	60.7	65.3
17	40	139.0	36.0	94.3	69.3	81.3
19	40	159.3	36.0	98.3	70.0	85.0
21	40	173.0	36.0	106.2	81.2	92.0

It is improbable that the quantity of *Trichoderma* in tea soils could be increased by inoculation with this fungus, but as it grows saprophytically on dead organic material, any cultural measure that increased the amount of organic matter in the soil might also help to build a better balanced microflora in the soil; this in turn might result in inhibition of the spread of *Poria* from one tea bush to the other. To test this supposition a pot experiment has been started.

(II.) **Virus diseases.**— Phloem Necrosis virus disease.—The question of the influence of temperature on the appearance of symptoms has been studied further. Diseased cuttings which showed apparently healthy growth at Neuchatel estate in the low country were transferred back to the high country to see whether they remained free from symptoms. Inside a hot room in the plant house of the laboratory, diseased plants threw out apparently healthy shoots.

On the instigation of Dr Hutchinson, the Division is assisting Mr Cranham in the search for a vector of the virus, by hanging yellow-coloured sticky boards amidst diseased tea bushes on three estates. These boards serve for the collection of all insects flying by day and by night in the immediate neighbourhood. Only the leafhoppers (which are the potential transmittors of the virus) are preserved and they are sent away for identification of species.

A new form of Phloem Necrosis, expressing itself mainly as severe defoliation, has been discovered at Pedro estate. In this case the Phloem Necrosis is very severe and leads to abscission of the leaf. Apart from a vague vein-clearing pattern in the leaves, no other outward symptoms have been seen.

Other virus diseases.—No progress was made with transmission of other virus diseases by grafting or budding. A variety of symptoms have been recorded in paintings for publication.

III. **Physiological diseases.**—1. Symptoms and cure of magnesium deficiency.—A cure for a lower-leaf chlorosis that is due to magnesium deficiency was further investigated on an estate and also on plants in pots; the results obtained late in 1958 were confirmed. The analysis of sprayed and unsprayed leaves gave the results contained in Tables 3 and 4.

Table 3.—*Magnesium content of mature leaves taken at random from the maintenance foliage of Court Lodge Clone* 72 *sprayed weekly with magnesium sulphate solutions at* $\frac{1}{2}$ *gal. per* 10 *bushes. The leaves were washed before analysis*

Spray treatment	Number of treatments	Magnesium content p.p.m. in dry matter
10% $MgSO_4.7H_2O$	6	682
2% $MgSO_4.7H_2O$	24	455
Nil (control)	—	227

Analysis of samples of chlorotic and healthy leaves showed a marked difference in magnesium content. Healthy plucked leaf has about 2,200 p.p.m. (Eden, 1958), but healthy mature leaves have only 200–300 p.p.m.; mature chlorotic leaves, on the other hand, tend to have under 100 p.p.m. of magnesium.

Table 4.—*The effect of foliar spray and soil injection of magnesium sulphate*

Treatments	p.p.m.	No. of treatments	Quantity of $MgSO_4$ applied in grams per bush
(1) 2½% $MgSO_4$ injected	136	8	36.5
(2) 2½% $MgSO_4$ sprayed	237	8	18.3
(3) 1% $MgSO_4$+Aastickol sprayed ...	227	33	30.1
(4) 1% $MgSO_4$ sprayed	455	33	30.1
(5) 1% $MgSO_4$ injected	91	33	60.4
(6) Control	91	Untreated	—
(7) 5% $MgSO_4$ sprayed	682	8	36.5

The Titan yellow method used for this estimation of magnesium is a rather rough method giving approximate values. An improvement can be achieved if the ash is treated with ammonium sulphide in order to eliminate other elements that interfere with the magnesium test.

In order to get a fuller picture of the occurrence of magnesium in the tea plant, various other analyses were done. Experiments were started on curing magnesium deficiency in clonal material by ordinary manuring and by spraying magnesium sulphate mixed with blister-blight fungicide.

2. Symptoms and cure of nitrogen deficiency in clonal material.—A preliminary experiment on curing acute nitrogen deficiency in clone TRI 2024 showed that yellow and pinkish leaves at the tips of shoots react to a 6% urea spray by turning green. Some burning effect has also been noted. A urea spray could probably be of use in nurseries and clonal areas and could be combined with fungicidal sprays. The question of corrosion of equipment has, however, to be considered.

3. Oilspot disease.—Results obtained both in the field and in the laboratory show that:—

1. the symptoms occur only on old bushes above 6,000 ft.;
2. pruned bushes develop acute symptoms of necrosis on those shoots that are situated on the side of the bush that showed Oilspot before being pruned;
3. when transpiration from the leaves is reduced or made impossible by placing a plastic cover over the bush, then the symptoms of Oilspot do not develop at all or develop much later than under normal conditions;
4. cuttings taken from diseased bushes develop healthy growth;
5. Oilspot bushes are usually found on a rather deep soil with a heavy, dark brown, layer of clay at a depth of about 4 feet. This indicates ample water supply. At one estate it has been reported that the fields in which Oilspot bushes occur never suffer from drought, indicating a very good water supply;
6. symptoms are worse on the rapidly growing shoots, with a high transpiration, that develop immediately after pruning;
7. Oilspot bushes have been found only in unshaded or very lightly shaded areas;
8. the oil spots originate around the stomata on the undersides of the leaves;
9. leaves of normal size do not show Oilspot before reaching maturity.

From these observations the following conclusions can be drawn:—

(i) no parasitic organism is involved, for any parasitic attack would develop as well or better under conditions of high humidity;
(ii) adequate or high water supply to the roots, and high evaporation from the leaves, favour the development of the symptoms; in other words, a rapid transport of water through the plant favours the disease;
(iii) the symptoms develop best under conditions of low air humidity.

The following hypothesis is put forward to explain these effects: Some substance, coming either from the soil or from old wood, is accumulated in the leaves under conditions of low air humidity. This substance is transported with the transpiration stream at a concentration at which it does no harm. Due to evaporation in the leaves, it reaches higher concentrations there, at which it can either stimulate growth (formation of corky excrescences) or kill cells (Oilspot). This substance is taken up only by old bushes which

have penetrated to layers of the soil that are badly aerated and very wet. Experiments have been planned for the purpose of investigating this hypothesis.

Chemical analysis for the elements P, K, Ca, Mg, Fe, Al, B, Cu, Mn, and Zn showed that none of these elements is present in excess in diseased leaves.

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ANNUAL REPORT OF THE PLANT PHYSIOLOGIST FOR 1959

T. Visser, Dr Ir.

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1. General.—I was on leave for three months during the first half of the year and Dr D. Mulder then acted for me. I was in charge of the Nematology Division until Dr M. T. Hutchinson took over in August.

The staff was increased by three Assistants, namely, Mr S. Nagarajah in February and Messrs A. R. M. Hassim and N. S. Rajendram in December.

Advisory.—Altogether 800 letters were received and 1,010 were despatched. A total of 170 visits were made to estates, the majority for experimental purposes. More than half the letters and visits concerned vegetative propagation and selection, and they were dealt with by the Vegetative Propagation Officer, Mr F. H. Kehl.

2. Side Pruning and Plucking along the Periphery.—Both experiments—briefly reported in the Annual Report for 1958 (Visser, 1959)—were designed to restrict the size of the bush, for example when agricultural operations become difficult because of vigorous spreading or too close planting.

2.1 Side Pruning.—This operation consists of pruning about 1/6th of the bush on both sides along the row at some time during the pruning cycle. The experiment was carried out in each of three fields which differed in age and bush size. Side-pruned and unpruned bushes were compared, each treatment in each field being replicated 6 times (plot size 1/20th acre). The bushes were side pruned in all three fields simultaneously (March 1958) at a height of 12″ to 15″ and in such a way that the width of the remaining centre was approximately the same in each field.

After pruning, it was observed that the sides at first recovered relatively quickly, forming shoots of some length within 10 weeks, but subsequent growth appeared to be impeded. Presumably, the stimulating influence of pruning gradually diminishes and the central portion of the bush asserts itself, as it is inherently in a stronger nutritional position. If a pre-pruned bush has its centre pruned at 6—8 weeks after side pruning, the shoots at the sides grow normally and unimpeded.

Calculated bush-areas (based on measurements of 10 bushes per plot) and yields recorded in the different fields are given in Table 1.

TABLE 1.—*Average area per bush in square feet and yields (lb tea/acre) of unpruned (NP) and side-pruned (SP) bushes before (1st 16 plucks) and after (2nd 16 plucks) the sides were brought into plucking again*

(Figures *in italics* are standard errors of bush area; within parentheses are sizes and yield of side-pruned bushes as percentages of those of corresponding unpruned bushes; *non-significant difference in yield between treatments).

	1	2	3	4	5	6	7	8	9
	Field No. 9, 19 mths after pruning			Field No. 4, 44 mths after pruning			Field No. 3, 33 mths after pruning		
	NP	SP		NP	SP		NP	SP	
Bush area in sq. ft.	14.22 ±0.92	6.59 ±0.25	(46.4)	11.63 ±0.69	5.90 ±0.20	(50.9)	9.88 ±0.70	5.89 ±0.33	(59.6)
Yield 1st 16 plucks	611	426	(69.7)	501	413	(82.4)	209	280	(90.6)
Yield 2nd 16 plucks	534	555	(103.9)*	266	288	(108.3)	238	281	(118.1)
Total	1145	981	(85.7)	767	701	(91.4)	547	561	(102.6)*

The yields of the side-pruned bushes (columns 2, 5, 8) were proportionally higher as the proportion removed was relatively smaller (columns 3, 6, 9). It is worthy of note that the part of the bush remaining after side pruning yielded over the first 16 plucks between 70 and 90% of the control, though its bush surface was only between 46% and 60% of that of unpruned bushes. Probably both the predominance of the centre (Cohen Stuart, 1930; Tubbs, 1932; Visser & Tillekeratne, 1958) and the improved light conditions following side pruning explain why the yield dropped less than the bush surface. The yield over the second 16 plucks, after the sides were brought into plucking, exceeded that of unpruned bushes in all instances. The total yield of the side-pruned bushes in Field No. 3, where the smallest area was removed, was about the same as that of unpruned bushes.

Accordingly, side-pruning can be applied without loss of crop in cases where, due to too close planting, agricultural operations become difficult before the bushes have run their intended cycle.

2.2 Plucking Level Experiment.—This experiment was started in April 1958, preceded by pruning in October 1957, and consisted of the following treatments:—(*a*) normal plucking with breaking back, (*b*) normal plucking without breaking back (dome plucking), (*c*) normal plucking combined with plucking below the plucking level around the periphery. Each treatment was replicated 6 times (plot size 1/20th acre); the results over the first 70 plucking rounds are shown in Table 2, together with the average diameter and height of the bushes (based on 10 bushes per plot) 27 months after pruning.

TABLE 2.—*The effects of different plucking methods on yield in lb. tea/acre*

(Figures within parentheses represent yields, diameters, and heights expressed as percentages of those of the control; the diameters and heights of bushes are given at 27 months after pruning).

Plucks	Normal plucking	Dome plucking	Periphery plucking
1 — 10	531	513 (99.6)	635 (119.6)
11 — 20	338	305 (90.2)	406 (120.1)
21 — 30	437	375 (85.9)	484 (110.7)
31 — 40	293	260 (88.7)	309 (105.5)
41 — 50	349	310 (88.8)	374 (107.2)
51 — 60	228	195 (85.5)	234 (102.6)
61 — 70	367	306 (83.4)	382 (104.1)
Total	2543	2260 (88.9)	2824 (111.0)
Diameter	49″	49″ (100.0)	47″ (95.9)
Height	35″	40″ (114.3)	35″ (100.0)

It can be seen that dome plucking yielded consistently less, and periphery plucking consistently more, than the control. In both cases the yield tended to fall, compared with the control, so that the disadvantage of dome plucking increased, and the advantage of periphery plucking decreased. Periphery plucking yielded significantly more than other treatments over the first 30 plucks. Dome plucking yielded significantly less than the other treatments over the last 50 plucks. Periphery plucking had only slightly reduced the diameter of the bushes—but movement through the rows was easier—while dome plucking increased their height. The dome-plucked bushes had a rather irregular plucking surface and were higher in the centre.

The diminishing effect of peripheral plucking with time is probably mainly the result of increasing shade along the periphery as the bush grows and expands, so that light intensity becomes insufficient for photosynthesis, and therefore for flush production, below the plucking table.

These results on dome plucking confirm those obtained by Eden (1945) over the first cycle (1940-1944) of the old fish-leaf experiment. These findings are given in Table 3.

TABLE 3.—*Effects of different plucking methods on the yield for the first cycle* (1940-44) *in lb. tea per acre*

	Normal plucking	Fish-leaf plucking
Breaking back	3588	4532
Not breaking back	2452	4324

The above figures show that not breaking back (of banjis) resulted in a marked loss of crop (32%) when normal plucking is done, but had little effect on yield (loss only 5%) when fish-leaf plucking is resorted to. To a smaller degree the effect of breaking back is like that of hard plucking, but is much less drastic, as the loss in total growth (flush, foliage, wood) amounted to only 7% and that caused by fish-leaf plucking was 36%, compared with the control, over the pruning cycle.

Presumably, not breaking back gradually reduces the number of plucking points as it provides less stimulation to growth.

In conclusion it can be stated that plucking combined with *breaking back* is a recommendable practice; *peripheral plucking* appears to be feasible, with a view to retarding lateral growth of the bush, and it may provide an alternative to side pruning.

3. Fish-leaf plucking.—Three experiments on fish-leaf plucking have recently completed a part of their experimental period, which warrants a more extensive report than previously given.

3.1 Old fish-leaf plucking experiment.—This trial completed its 6th cycle of 3 years in November 1958. The more important effects are shown in Table 4 in which the symbols represent the following treatments:—(*a*) SS—continuous single-leaf plucking; (*b*) FF—continuous fish-leaf plucking; (*c*) SF—single-leaf plucking in the previous cycle and fish-leaf plucking in this cycle; (*d*) FS—fish-leaf plucking in the previous cycle and single-leaf plucking in this cycle.

TABLE 4.—*Dry matter distribution for different plucking treatments in lb. per acre*

(Figures within parentheses represent weights expressed as percentages of those of the control.)

Treatments	Flush	Foliage	Wood	Total
(*a*) SS	3495 (100.0)	2716 (100.0)	7032 (100.0)	13,243 (100.0)
(*b*) FF	3779 (108.1)	936 (34.5)	1708 (24.3)	6,423 (78.5)
(*c*) SF	4513 (129.1)	1172 (43.2)	2204 (31.1)	7,889 (59.6)
(*d*) FS	3113 (89.1)	2644 (97.3)	6212 (88.3)	11,969 (90.4)

It will be seen from Table 4 that trends obtained in the 5th cycle (Kehl & Piyasena, 1956) have been maintained. Continuous fish-leaf plucking yielded somewhat more than continuous single-leaf plucking, but the bushes formed only 1/3rd of the foliage and 1/4th of the wood as compared with the control. Bushes single-leaf plucked previously but fish-leaf plucked in this cycle (*c*) showed a considerable increase in yield but again lost greatly in foliage and wood.

It can be further noted that the deleterious effect of fish-leaf plucking in the previous cycle can be all but overcome in the next cycle when single-leaf plucking is resorted to (*d*).

3.2 Plucking-cum-pruning-cycle experiment (Endane)—This experiment was laid down in a field planted in 1952, and began its first cycle after pruning in September 1956. The 12 treatments (each 6 times replicated; plot size 1/15th acre) have been described previously (Visser, 1958). The yields up to September 1959, when the plots with 1½ and 3-year pruning cycles were simultaneously pruned, are given in Table 5.

TABLE 5.—*Yields in lb. of tea per acre over 3 years as affected by pruning cycle, manuring, and plucking method*

(The critical difference of the average is 343 lb./acre at P=0.05).

Cycle lengths	Manuring at: 8 lb. N	12 lb. N	Plucking Single	Fish	Average
1½ years (134 rounds) ...	4732	4949	4530	5151	4841
2 ,, (134 rounds) ...	4368	4516	4274	4610	4442
3 ,, (146 rounds) ...	4185	4322	3941	4566	4254
Averages ...	4428	4596	4248	4776	

Statistical analysis showed that no significant interactions existed between manuring and cycle-length, between manuring and plucking treatment, or between plucking and cycle-length.

The effect of manuring on yield is, though significant, very small; manuring at the higher ratio increased the crop by only 3 to 4%. Fish-leaf plucking had a relatively greater effect, yielding an average of 12% more than single-leaf plucking. This increase is not very marked when compared with the 30–35% extra yield obtained in a similar experiment at St Coombs (*see* 3.3). It is possible that a further depletion of the already limited maintenance foliage of the fish-leaf-plucked bushes by Shot-hole Borer and Red rust attacks has been the cause of the relatively small increase; on the other hand, other anomalous results have been obtained in manurial trials on this particular estate. Limited fish-leaf plucking did not appear to have harmed the bushes, as recovery—in terms of tippings—was as good as, and die-back no worse than, that of single-leaf-plucked bushes.

The bushes pruned every 1½ years have so far yielded significantly more than bushes pruned every two or three years. In the case of the two-year cycle, it is too early to say whether the decrease will be maintained, for the 1½ and 2-year cycles are only comparable 6 years after the experiment has started.

With regard to the lower yield (by 13%) of the 3-year cycle, this is almost certainly due to the difficulty in plucking the bushes efficiently in their 3rd year because of their great height. The heights of bushes (based on 5 bushes per plot) at the end of their pruning cycle (September 1959) are given in Table 6.

TABLE 6.—*Pruning heights of bushes in inches (and standard errors) after pruning cycles of 1½ and 3 years*

Plucking treatment	1½-year cycle	3-year cycle	Average
Single-leaf	46.6 ± 0.72	79.2 ± 0.74	63.4
Fish-leaf	39.8 ± 0.10	67.4 ± 0.11	53.6
Average	43.2	71.8	

As can be seen from Table 6, bushes which had run for three years were on average almost 6 feet high and nearly 2½ feet higher than bushes pruned every 1½ years. Fish-leaf plucking depressed the height of the bushes by an average of 10 inches.

Following pruning of the 1½ and 3-year-cycle plots at average heights of 22.8″ and 19.9″ respectively it was found that the 3-year bushes had nine times more die-back than the 1½-year ones, probably due to the lower pruning height.

Although the experiment is not completed, it can already be said that a pruning cycle of 3 years is not a practical proposition in the low country. Fish-leaf plucking, if done for part of the cycle only, appears to have possibilities, but one should guard—by a few rounds of resting if needed—against the danger of lossing maintenance foliage through extraneous causes.

3.3 New Fish-Leaf Plucking Experiment.—This trial began in April 1955 (field pruned) and completed its first cycle in September 1959.

The following treatments (replicated 5 times; plot size 1/32nd acre), manured at both a normal ratio (8 lb. N/100 lb. tea) and a high ratio (12 lb. N/100 lb. tea), were tested:

(*a*) SSSS—normal plucking throughout;
(*b*) SSFF—1st and 2nd year normal plucking—then fish-leaf plucking until pruning;
(*c*) SFFR/R—1st year (33 rounds) normal plucking—then fish-leaf plucking—6 months resting before pruning;
(*d*) SFFF/S—1st year normal plucking—then fish-leaf plucking—6 months normal plucking (preceeded by 3 rounds resting).

Statistical analysis indicated that there was no interaction between manuring and plucking treatment, that is to say, manuring at 12 lb. N as compared with that at 8 lb. N/100 lb. tea, led to approximately the same increases in yield over the cycle (between 15 and 21%) irrespective of plucking treatment. The yearly yields have been presented in Table 7.

TABLE 7.—*Yearly yields in lb. tea per acre averaged for both manuring treatments as affected by plucking method*

Treatments	1st year 33 rounds	2nd year 40 rounds	3rd year 40 rounds	4th year 42 rounds*	cycle yield
(*a*) SSSS	862	1156	1342	1049	4409
(*b*) SSFF	846	1108	2032	1685	5671
(*c*) SFFF/R	850	1541	2295	1070	5756
(*d*) SFFF/S	839	1512	2223	1386	5960

*42 rounds for treatments (*a*) and (*b*); only 24 rounds for (*c*) and 39 for (*d*).

It can be seen from Table 7 that fish-leaf plucking increased the yield by 35% over the 2nd year (comparing *c* and *d* with *a* and *b*), by 68% over the 3rd year (comparing *c* and *d* with *a*) and by 61% over the 4th year (comparing *b* with *a*). It is worthy of note that treatment SFFF/R yielded over 24 rounds of fish-leaf plucking in the 4th year as much as the normally plucked control (SSSS) over 42 rounds. The fish-leaf plucked treatments yielded over the

cycle 29 to 35% more crop than the control, but at the cost of an average loss of 18% in prunings (foliage and wood). This loss is not great when compared with a loss in prunings of 49% incurred following the first cycle of *continuous* fish-leaf plucking in the old fish-leaf plucking experiment (Eden, 1949).

After fish-leaf plucking, a period of 6 months of normal plucking restored maintenance foliage to the same level as that of the control at the time of pruning; bushes rested for 6 months had 25% more foliage than the control. With the exception of the latter, fish-leaf-plucked bushes were significantly lower than the single-leaf plucked ones; the heights at pruning were for SSSS, SFFF/R, SSFF and SFFF/S 41.5″, 43.1″, 32.8″ and 32.2″ respectively at the end of the cycle.

Judging by the tipping weights recorded after pruning, recovery was unimpaired in bushes fish-leaf plucked for part of the cycle. Also the ground cover they provided was no different from that of single-leaf-plucked bushes, as bush circumferences were virtually the same (for SSSS, SFFF/R, SSFF, and SFFF/S, 167″, 166″, 170″ and 163″ respectively).

From the evidence in hand it would appear that limited fish-leaf plucking can be applied with advantage. However, it must be stressed that fish-leaf plucking can only be applied on bushes which are in *good* health. At up-country and mid-country elevations it should be preceded by at least 10 months of normal plucking in order to allow the bush to form a good canopy of maintenance foliage. Furthermore, it is most advisable to *rest* the bushes for several months before pruning. In the low country, fish-leaf plucking, if applied, should be done only during the last 9 months of the $1\frac{1}{2}$ years pruning cycle.

Whenever undue defoliation occurs, a few rounds of resting, followed by 1 or 2 rounds of normal plucking, should be resorted to before resuming fish-leaf plucking. This situation is likely to arise in the mid-country because of mites, Shot-hole Borer, Nettle Grubs or drought; and therefore only limited fish-leaf plucking should be applied, and that with caution. In the low country, Red rust could be a possible cause for the depletion of maintenance foliage.

In *fields earmarked for replanting*, continuous fish-leaf plucking should be the general practice; the extra crop obtainable (of the order of 500–1,000 lb. over 3 years) will help to offset the costs of replanting.

4. Pruning Experiments at Passara and at Downside Estate, Welimada.

4.1 Passara (Gonakelle Estate).—In order to substantiate the findings of previous pre-pruning trials (Visser, 1958, 1959) and to evaluate seasonal effects and the part played by old and new foliage as regards recovery, an extensive trial on different pruning methods has been begun at Passara. The following treatments are to be compared: *pre-pruning* (about 1/5th on each side of the bush) 6 and 8 weeks respectively before the main prune; *half-pruning* (about 2/5th on one side of the bush) 5 and 8 weeks respectively before the main prune; *rim-lung pruning* leaving 3 and 6 lungs respectively; *cut-across* at about 15 inches.

Pruning will be carried out in October 1959, February 1960 and July 1960. Each of the 7 treatments is to be replicated 5 times in every season (plot size—1/24th acre).

4.2. Downside.—The pruning-cum-cultivation trial at this estate was laid down in November 1956; the treatments were described in a previous Annual Report (Visser, 1957). Analysis of the yields over the first two years showed that pre-pruning increased the yield significantly over the first year (by 11%), but had no effect on yield in the 2nd year after pruning. No significant trends were observed as regards the cultivation treatments: trenching, forking, and rate and frequency of manuring.

5. Experiments on Clones.

A number of trials on clones, dealing with operations in the initial stages of planting, have given results of some practical interest which are summarised below.

5.1 Bringing into Bearing.—The experiment at *St Coombs*, initiated in July 1958, consisted of 10 treatments on clones TRI 777 and TRI 2024, replicated 5 times on TRI 777 and 6 times on TRI 2024 (6—8 plants/clone/plot). The following practices were compared: centering or breaking at 6-7″ carried out 5 or 6½ months after planting; cut-across at 12″ about 9½ months after planting; thumb-nailing 2 or 7 times; bending 4 times started 5 or 6½ months after planting.

In terms of root, leaf, and shoot growth (assessed 16 months after planting), bending and the late cut-across gave results much superior to those obtained with the other treatments. Early centering and frequent thumb-nailing (7x) gave the poorest results. Plants thumb-nailed only twice produced less good growth than expected, presumably because the first thumb-nail was carried out too early (3 weeks after planting) which severely checked growth. Breaking of shoots so that they were still partly attached, instead of cutting them off entirely, improved growth to some extent. The experiment clearly indicated that the less the plants were touched at an early stage, the better their growth.

At *Endane* a replicated experiment (5 times, plot size 1/5th acre) on seedling tea was laid out in 1956 consisting of the following treatments: layering or bending followed by a cut-across at 12″ and 30″; cut-across at 2″, 4″ and 8″; thumb-nailing; bending combined with thumb-nailing.

Judging by shoot and leaf assessments in July 1959, and subsequent yield over the first 9 plucks, both thumb-nailing and also bending plus thumb-nailing had been more successful as bringing-into-bearing operations than cutting across, whether or not preceeded by layering or bending. Since nearly all replanting is nowadays done with clonal material it is proposed to replace this experiment by one on clones, also under estate conditions.

5.2. Interplanting with cover and bush crops.—A duplicated experiment was laid down by Mr F. H. Kehl at Neuchatel in June 1958 with seven-months-old basket plants of clones TRI 25 and TRI 2026 (2 × 10 plants/clone/treatment) to determine the effect of growing a cover crop, *Stylosanthes gracilis*, and a bush crop, *Crotalaria anagyroides*, amongst young tea in clearings. The seed of the former was sown 6 days and that of the latter 4 days before the planting of the tea. The *Crotalaria* was lopped in August 1958, October 1958, and January 1959; *Stylosanthes* was lopped around the young tea at a radius of about 8–10 inches in January, February and April 1959. The plants were assessed in June 1959 and the results are given in Table 8.

TABLE 8.—*Deaths and growth under cover crop and bush manure*

Treatments	% dead	Mean diameter at base in cm.	Mean No. of leaves per plant
(*a*) No shade	12.5	1.29	221.9
(*b*) Fern	0	1.52	284.6
(*c*) *Crotalaria anagyroides* in alternate row—lopped and thatched	17.5	1.03	153.7
(*d*) *Crotalaria anagyroides*—in both rows—lopped and thatched	3.0	1.03	187.7
(*e*) *Crotalaria anagyroides*—alternate rows—unlopped	37.5	1.04	147.1
(*f*) *Stylosanthus gracilis*—alternate rows ...	35.0	0.82	83.2
(*g*) *Stylosanthus gracilis*—both rows	52.0	0.69	54.9
(*h*) *Stylosanthus gracilis* and *Crotalaria anagyroides* in alternate rows	37.5	0.85	86.5

Table 8 shows that the smallest number of casualties occurred and the best growth was recorded in tea under fern (*b*), second, in tea with no shade (*a*), and third, in tea with *Crotalaria* in both rows which were lopped and thatched (*d*). The results with *Crotalaria* in alternate rows lopped (*c*) or unlopped (*e*) were less good, possibly because on the one hand less shade is given and on the other more competition is incurred than with *Crotalaria* lopped in both rows. Plots with *Stylosanthes* (*f, g, h*) recorded a higher number of deaths and showed the least growth.

It is evident from the results that the growing of a cover crop in alternate or both rows, or together with a bush crop, has an adverse effect on young tea growing in a light soil, presumably as a result of the cover crop competing with the tea for moisture.

5.3. Shade experiment.—The lay-out of this trial has been described previously (Visser, 1959). The plants at St Coombs, Passara, and Neuchatel, were put under their respective shades by the middle of this year and have been assessed twice between September and December 1959.

Although the experiment is not yet completed, nor the figures fully analysed, the following trends may be noted:—

(*a*) the highest plant weights and leaf areas per plant were recorded at light intensities between 60 and 100%; the growth of the plants at 40% light intensity was markedly less than with less shade;

(*b*) correlations between dry weights of tops (leaves + shoots) and of roots were highly significant (of the order of 0.9); the top/root ratios were not significantly affected by changes in light intensity;

(*c*) the sizes of the individual leaves decrease and the nett assimilation rate (of the order of 100–150 mg/100 cm. leaf area/week) increases with increasing light intensity.

The results so far obtained are similar to those of Barua (1956) who used a different type of shade.

5.4. Partial defoliation.—The part played by maintenance foliage in flush production was investigated by partly defoliating the bushes. In this trial clonal bushes (in their 3rd year after pruning), of which the total leaf-number had been determined beforehand on one bush per clone (on average 3,400 per bush), were treated as follows: (*a*) not defoliated; (*b*) one quarter and (*c*) one half of the maintenance leaves removed from below the plucking table upwards. Each treatment was represented by one bush of each of 14 clones (divided into two sets of 7). The results are given in Table 9.

TABLE 9—*Fresh weight in ozs. per 7 bushes (average of 2 replicates) following partial defoliation*

(Figures within parenthesis represent yields as percentages of the control.)

Period days	Plucks	Control (*a*)	One quarter (*b*)	One half (*c*)	Mean of Treatments (*b*) & (*c*)
90	0—10	155	123 (79.5)	137 (88.4)	130.9 (83.9)
89	11—20	150	152 (101.3)	144 (96.0)	148.9 (98.7)
90	21—30	125	112 (89.6)	126 (100.8)	119.1 (95.4)
91	31—40	117	116 (99.1)	113 (96.6)	114.5 (97.4)
	Total	547	503 (92.0)	520 (95.1)	511. (93.4)

It can be seen from Table 9 that the yields of the partly defoliated bushes showed fluctuations relative to the control which are probably not chance. It is likely that these are caused by a combination of factors, such as the initial reduction in carbohydrate production and reserves, and "wound stimulus" following leaf removal and the subsequent increase in leaf area. The yield of the half-defoliated-bushes varied less from the control than that of the one-quarter-defoliated-bushes, possibly because the removal of half the leaves provided better light conditions and more wound stimulus than removal of a quarter of the leaves.

Leaving aside the first series of 10 plucks, the mean yield of the partly defoliated bushes did not differ much from that of undefoliated bushes. The first 10 plucks show a loss of 12% for the half-defoliated bushes (as compared with undefoliated bushes) which is little, taking into account the relative large loss of maintenance foliage. Probably the foliage removed contributed little to carbohydrate production because light conditions under the plucking table were unfavourable for photosynthesis.

It may be noted that relative yield trends following partial defoliation were almost indentical to those observed by Tubbs (1932a) with completely defoliated bushes. In Tubbs's trial, however, the loss in yield over 6 months amounted to 57%, in our case to only 9% over the same period.

Apparently, limited losses of maintenance foliage under the plucking table due to diseases or pest will not effect the yielding capacity of the bush unduly.

6. Guatemala Trials.—Two simple trials were initiated by Mr F. H. Kehl at both sub-stations in order to investigate the effect of planting distance and manuring on the growth of Guatemala grass.

6.1 Passara.—The treatments consisted of 4 plots planted at a spacing of $1\frac{1}{2}' \times 1\frac{1}{2}'$ and 4 plots at $2' \times 2\frac{1}{2}'$; two levels of manuring were given to two plots of each of the different spacings. The application rates were as follows: 1st application of 2 and 4 cwt. per acre of standard Guatemala mixture soon after the grass had established; 2nd and 3rd applications at 4 and 8 cwt. per acre after each cut. The size of each plot was 1/8th acre; the grass was planted in March 1958.

TABLE 10.—*Fresh-weight yields of Guatemala grass loppings in lb. per/acre*

Treatment	1st cut Dec. 1958	2nd cut April 1959	3rd cut Oct. 1959	Total
$1\frac{1}{2}' \times 1\frac{1}{2}'$ ...	12,530	7,970	24,510	45,010
$2' \times 2\frac{1}{2}'$ ...	9,940	7,790	25,490	43,220
High manuring ...	11,730	8,580	29,530	49,840
Low manuring ...	10,740	7,180	20,470	38,390

As shown in Table 10, the first cut of the grass spaced at $1\frac{1}{2}' \times 1\frac{1}{2}'$ gave a higher return (by 2,600 lb. per acre or 26%) than the grass planted at $2' \times 2\frac{1}{2}'$, but thereafter the yields of the two spacings differed insignificantly. The difference in the totals at the end of the three cuts is only 4% in favour of the narrow spacing. Thus it appears that apart from the quicker cover and higher early yield obtained by closer planting, there is no other advantage. Higher yields have been obtained throughout by high manuring, increasing the yield for the three cuts by 30% (11,400 lb. per acre) as compared with manuring at a half rate. The average yield for the three cuts amounted to nearly 20 long tons per acre.

6.2 Neuchatel.—The experiment on Guatemala grass was similar to the one at Passara (treatments duplicated), but with the additional treatment of two cuttings planted per hole. Manure was applied at two rates of 3 cwt. and 6 cwt. per acre respectively. The grass was planted in October-November 1958. The results obtained so far are given in Table 11.

TABLE 11.—*Fresh weight yields of Guatemala grass loppings in lb. per acre*

Treatments	FRESH WEIGHT YIELDS			Total
	1st cut May 1959	2nd cut July 1959	3rd cut Dec. 1959	
$1\frac{1}{2}'' \times 1\frac{1}{2}''$ ...	18 545	26,375	35,905	80,825
$2' \times 2\frac{1}{2}'$ ...	13,345	23,315	32,430	69,090
High Manuring ...	17,140	27,910	39,615	84,665
Low Manur ng ...	14,745	21,780	28,720	65,245
Single Cutting ...	16,375	26,325	31,875	74,575
Double Cutting ...	15,515	23,365	36,460	75,335

As in Passara, the difference in yield between the two spacings decreased with time, the total yield obtained from the narrow spacing being about 17% higher than that from the wider spacing. The yields of the plots manured

at the higher rate have progressively increased, more markedly at each cut than at Passara, the total increase amounting to 30% (19,420 lb. per acre) as compared with manuring at the lower dosage.

The plots with two cuttings planted per hole gave a lower yield at the first two cuts (by 9%) and an unexpected increase of 14% over the plots with one cutting per hole at the 3rd cut. This increase was due to the yields of the two-cutting plots becoming more responsive to high manuring than the yields of the single-cutting plots at the third cut. It is not possible to say at this stage whether this effect is significant or accidental.

7. Carbohydrate studies.—Research on the carbohydrate reserves of tea roots has been started again after an interval of about 25 years. Mr S. Nagarajah was made responsible for these investigations.

The method of analysis previously adopted was not used, because of its tediousness, and much time was devoted to finding a more suitable technique. The essentials of the method applied since are as follows: extraction of foreign substances and soluble sugars from finely ground samples of tea roots, then cleaning and anlysing the extract for soluble sugars. The starch remaining in the residue is gelatinised and enzymolised by using *saliva*; the glucose obtained by the hydrolysis of the starch is estimated by the method of Lane and Eynon (1934). It appeared that the roots of mature bushes contain quantities of soluble sugars that are too small to be estimated accurately by this method. Consequently the work has been limited to the determination of starch reserves only.

Investigations at present are concerned with the development of a quick sampling method for both sugars and starch.

Some preliminary observations may be noted:—

(*a*) bushes plucked normally throughout had larger reserves at the end of a 4-year cycle than bushes fish-leaf plucked during the later half of the cycle. However, resting of such bushes before pruning restored the reserves to the level of that of the control;

(*b*) bushes continuously fish-leaf plucked for several pruning cycles would seem to mobilise their reserves after pruning at a slower rate than bushes plucked normally throughout.

In connection with our investigations on carbohydrates, reference should be made to important work by Tubbs (1932, 1935) who found that starch reserves of tea roots increased linearly with altitude. It was thought that this phenomenon is probably largely a temperature effect, temperature being the most specific characteristic of elevation; accordingly, confirmation of this assumption was sought.

TABLE 12.—*Mean maximum, mean minimum, and average yearly temperatures at different elevations; and % starch reserves in tea roots at these altitudes, derived from Tubbs. The average temperature is the mean of the mean maximum and the mean minimum*

1	2	3	4	5	6
Station and elevation in feet	Temperature in °F			Average temperature in °C	Calculated percentage starch reserves
	maximum	minimum	Average		
Ratnapura—113	88.7	73.0	80.9	27.2	11.40
Kurunegalle—393	87.7	73.3	80.5	27.0	11.96
Kandy—1572	83.8	68.2	75.7	24.3	14.31
Badulla—2196	82.8	65.1	74.0	23.4	15.56
Passara—3300	76.7	63.4	70.1	21.2	17.77
Diyatalawa—4093	76.8	60.5	68.7	20.4	19.35
Talawakele—4500	72.2	57.7	65.0	18.3	20.17
Nuwara Eliya—6170	68.2	52.4	60.3	15.7	23.51

Table 12 gives yearly mean minimum and mean maximum temperatures recorded more recently (1954–1958) at 8 meteorological stations situated at different elevations. It also presents the percentage starch which would theoretically prevail at these elevations according to the formula calculated by Tubbs: $y=11.17 + 2.0\,x$ in which y is percentage starch and x is elevation in units of 1,000 ft. Figure 1 presents minimum and maximum temperatures and percentage starch as related to elevation and the relation between average temperature and percentage starch.

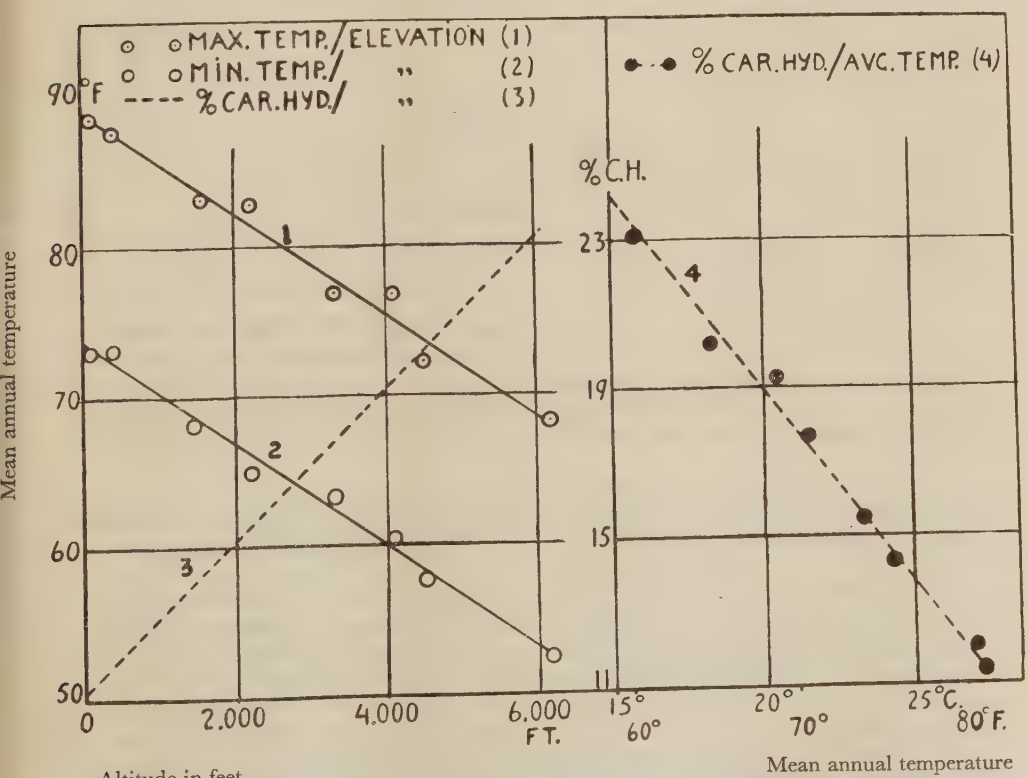

FIG. 1.—Relations between percentages of starch reserves in the roots of tea bushes and elevations above sea level (broken line, left); right, starch reserves and mean annual temperature. The two full lines on the left show the relationships between mean maximum and mean minimum temperatures, on the one hand, and elevation on the other.

It can be seen from Fig. 1 (left half) that the regressions for maximum and minimum temperature run virtually parallel and linearly decrease with increasing elevation. It follows that their average will correspond with elevation too ($y=81.50—3.44\,x$ in which y is mean temperature in °F and x is altititude in units of 1,000 ft.). The right half of the figure presents the highly significant regression (computed from the figures in columns 4 and 6 of Table 12) between temperature and starch reserves: $y=58.5—0.58\,x$, in which y represents percentage of starch and x mean temperature in °F.

Accordingly, it can be concluded that temperature is likely to be the dominant factor determining the starch reserves of tea roots.

8. Anatomical and Genetical Studies.

8.1 Blister-blight resistance and cuticle thickness.—The aim of these preliminary investigations, carried out by Mr K. L. D. Amaratunga, was to find out whether the thickness of the leaf cuticle affects the resistance of a clone to Blister Blight. For that purpose the average cuticle thickness was determined for each of 5 leaves of 10 clones. Clones with low, medium, and high susceptibility to Blister Blight were chosen. The susceptibility of these clones was found by assessing on 5 occasions the percentage infestation as represented by the number of shoots per 100 whose 3rd leaves showed infestation.

TABLE 13.—*Cuticle thickness and susceptibility to Blister Blight*

Clone	% infest	cut. thick. microns	Clone	% infest	cut. thick. microns	Clone	% infest	cut. thick microns
OK. 1	8	3.54	TRI 2022	36	4.32	TRI 2023	51	4.22
UR. 12	8	3.92	TRI 2025	37	3.34	TRI 25	55	3.65
TRI 2103	10	4.98	TRI 2024	40	3.88	TRI 777	55	3.64
			TRI 23	42	4.42			
Average	9	4.15	Average	39	3.99	Average	54	3.84

It can be seen from the data summarized in Table 13 that the average cuticle thickness tends to decrease with increasing infestation when the clones are grouped according to susceptibility. However, no clear-cut relation can be observed between susceptibility and cuticle thickness of the *individual* clones, as is also borne out by the insignificance of the correlation between the two factors (—0.2887).

It would seem from these preliminary results that cuticle thickness does not play an important part in the mechanism of blister blight resistance.

8.2. Phloem Index Investigations.—The frequency of calcium oxalate crystals in the phloem of the leaf petiole—*the phloem index*—has been shown by Wight and Barua (1954) and Barua (1956) to differ between clones and to be a sensitive quantitative index of metabolic changes associated with nutrient uptake. Our own findings confirmed that the phloem index is a genetical characteristic; the indices of clones planted at locations differing in elevation (St Coombs—4,500 ft., Passara—3,300 ft., and Neuchatel—100 ft.), soil conditions, and climatic conditions, appeared to be of the same order, irrespective of locality. It further appeared that the phloem index varied

significantly (within genetical limits) with the maturity of the leaf, position of the shoot in the bush, and shading density. It is thought that this characteristic may be of use in studies related to the determination and selection of clones.

8.3 Chromosome Numbers.—In order to find out whether polyploidy exists among clones selected by the Institute or by estates, the chromosome numbers of 35 clones have been assessed by Dr R. A. H. Legro of the Laboratory of Horticulture at Wageningen, the Netherlands, to whom our sincere thanks are tendered. From 23 of these, leaf weights were ascertained (mean of 100 3rd leaves/clone) to see whether the size of the leaf has any bearing on chromosome number. These clones have been tabulated in Table 14, which shows that leaf size may differ greatly from clone to clone.

TABLE 14.—*Leaf weight (in mg.) of 23 clones.*
The weight of the third leaf (mean of 100) is used as an indication of flush size

Clone	Weight	Clone	Weight	Clone	Weight
TRI 2093	102	TRI 2115	152	TRI 2088	220
OK. 1	108	VK. 9	153	TRI 2103	222
OK. 3	114	TRI 2092	163	TRI 1114	226
TRI 2078	121	TRI 777	170	KEN. 15/3	242
OK. 4	126	KEN. 15/7	173	TRI 2112	246
TRI 2075	140	CH. 56	194	TRI 2091	248
TRI 2065	143				
UK. 1	146				
Average 9 clones	125 (100.0%)	Average 7 clones	171 (136.8%)	Average 7 clones	239 (191.2%)

It appeared, however, that all of the clones had 30 chromosomes (diploid number). The same was found for TRI clones Nos. 23, 25, 740, 1076, 1526, 2016, 2021, 2022, 2023, 2024, 2025, 2026. Accordingly, among the 35 clones investigated neither leaf size nor yield—which varies markedly—are linked with chromosome number.

9. Selection and Vegetative Propagation.—This work has been carried out mainly under Mr F. H. Kehl.

9.1 St. Coombs.—During the year, cuttings of 7 new clones were planted in the nursery and 5 new clones were put out in the test plots. Altogether 53 additional clones, 48 from outside estates and 5 from St Coombs were ready for plucking towards the end of the year; but they were allowed to grow up as cutting material because the more promising clones were required for the other clonal-proving stations. The growth of these clones, except for a few, is below average, probably due to the soil being infested with Meadow Eelworm. Marigolds have been planted in this block with the object of reducing the eelworm population.

Some 41 clones planted in the wind-belt clonal area in 1953 and 1954 completed the first cycle of plucking. The calculated yields and the manufacture results of the better clones are shown in Table 15.

TABLE 15.—*Wind-belt clonal area. Calculated yields and Manufacture results for the 1st cycle.*

The grading on manufacture refers to up-country quality: A1—excellent; A2—good; B—fair; C—little up-country quality.

Clone	Origin	No. of plants	Calculated yields lb./acre				Manufacture
			1st yr.	2nd yr.	3rd yr.	Mean	
TRI 2151	St Coombs	13	1848	2970	3135	2651	A2
DK. 11	Diyanilakele	17	1502	2690	3251	2481	C
B. 95	Bogawana	11	1205	2541	2871	2205	B
TK. 42	Talankande	16	1337	1914	2376	1875	B
DK. 19	Diyanilakele	12	1155	1898	2459	1837	A1
W. 3	Wooton	13	858	1914	2343	1705	A1
D.N.	Diyagama	18	1089	1980	1980	1681	B
W. 14	Wooton	11	1040	2046	1815	1633	A1
DK. 8	Diyanilakele	17	1188	1848	1832	1622	A2
CH. 13	Craighead	19	1221	1733	1683	1545	B
RL. A	Rutland	6	891	1683	2030	1534	Not done
TRI 2142	St Coombs	13	875	1667	2046	1529	A2
DK. 1	Diyanilakele	14	809	1799	1931	1513	Not done

9.2 Sub-station, Passara.—I. GENERAL.—The Officer in Charge of the station visited 35 estates, maily in an advisory capacity or for the collection of clonal cuttings. He also supervised 21 pluckings of the experimental plots on Downside Estate, Welimada. Six visits were made to St Coombs, one to the clonal-proving Station at Neuchatel and one to Hantane in connection with the mid-country station. A meeting of the Uva Planters' Association, which was addressed by the Plant Physiologist, was also attended.

II. VISITORS.—The unofficial visitors to the station (Mr C. R. Burnett of Gonakelle and Mr F. H. Keun of Ury Group) visited the station on two occasions; 24 other members of the planting community also visited the station.

III. RAINFALL.—An amount of 76.46 inches of rain and a total of 170 wet days were recorded during the year.

IV. NURSERY.—About 12,000 cuttings of 51 clones were propagated during the year. The plants were used for the various V.P. experiments carried out during the year, for filling vacancies in the test plots, and for the establishment of 12 new clones. The establishment of a large number of mother bushes of popular T.R.I. clones was also completed.

V. MULTIPLICATION PLOT.—In just under two years from planting, 18 clones were brought into plucking towards the end of the year and 46 more will be ready for plucking early in 1960. The majority of the T.R.I. clones show better growth than the other clones, though about 6 clones from estates in Uva appear to be above average.

VI. PESTS.—Except for a mild attack of Yellow Mite, no pests of importance were noted during the year.

VII. TRANSFERENCE OF ROOTED CUTTINGS INTO BASKETS.—An experiment with 2 clones in duplicate (2 × 25 cuttings per clone) to determine the best age at which rooted cuttings should be transferred to baskets was laid out as follows:—(*a*) cuttings planted direct into baskets; cuttings transferred into baskets after they had been in the nursery for (*b*) 4 weeks, (*c*) 8 weeks, (*d*) 12 weeks, (*e*) 16 weeks and (*f*) 20 weeks respectively.

The cuttings were planted in April 1959, and assessed at the end of November 1959, about three months after the last lot of cuttings (treatment *f*) had been transferred into baskets.

It appeared from the results that cuttings planted direct into baskets made the least amount of growth. The fewest deaths were found to occur when cuttings were transferred from beds to baskets at 12, 16 and 20 weeks.

VIII. Other trials.—The Officer in Charge also assisted in the initiation and supervision of the experiments concerned with pruning methods (*see* 4. 1) and Guatemala grass (*see* 6. 1).

9.3 Sub-Station, Neuchatel.—I. General.—Part of the clonal area was flooded for a short period by the middle of the year and this did some damage to a recently-planted clonal block. It was noted that certain clones withstood flooding (lack of soil aeration) remarkably well, while a great number of deaths occurred in others.

A number of planters visited the station.

II. Rainfall.—A rainfall of 138.88 inches was recorded; the number of rainy days was 209.

III. Multiplication Plot.—Altogether 16 new clones were planted in the test plots; 64 clones planted in 1956 completed their first year of plucking. The yields were disappointing, 50 clones giving a yield of less than 700 lb. per acre. The yields of some of the more promising clones are given in Table 16.

Table 16.—*Calculated yields for the first year of first cycle*

Clone	Origin	No. of bushes	Calculated Yield per acre
18	Galatura	80	1625
TRI 2026	St. Coombs	117	1312
TRI 2022	do.	15	1130
Bal. 18	Balangoda	13	959
ED. 177	Ederapolla	19	905

IV. Other trials.—The Officer in Charge assisted with the initiation and supervision of the experiments on cover and bush crops (*see* 5.3) and on Guatemala grass (*see* 6.2).

9.4 Enselwatte.—Many of the clones in the 7-acre block on this estate would have been in plucking if they had not been allowed to grow up to provide cutting material for extensive replanting schemes. Clones in part of this block have been tipped and are to be brought into plucking early next year. The clones that appear to be outstanding are TRI 2023, 2024, 2025, 2026, 1114, CH.13, KEN. 16/3. A small block of TRI 2026, 1/10th of an acre in extent, which was planted in March 1957 and brought into plucking in May 1959, has given a yield of 988 lb. green leaf to the end of December.

10. Publications.—The following papers were published:—

Visser, T., Kehl, F. H., & Tillekeratne, L. M. de Waas (1959). Propagation of tea cuttings. I. Soil and nutrient requirements. *Bull. Tea Res. Inst. Ceylon* (New Series) no. 1: 1-15.

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Visser, T. (1959). The influence of the nodal leaf on rooting, growth and flower development, *Bull. Tea Res. Inst. Ceylon* (New Series) no. 1: 32-40.

Kehl, F. H., & Keegel, E. L. (1959). Report on visits to North-East and South India. *Tea Quart.* **30:** 71-85.

11. Acknowledgments.—The co-operation of Superintendents of estates who have offered clonal material for testing and trials is gratefully acknowledged. Our thanks are also due to the Managers and Assistants of Downside, Endane, Enselwatte, Gonakelle, Hantane, Neuchatel and Pedro Estates for the assistance they have given us during the year.

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Visser, T. & Tillekeratne, L. M. De Waas (1958). Factors affecting planting distances of tea. *Tea Quart.* **29:** 36-44.

Wight, W. & Barua, D. N. (1954). Calcium oxalate crystals as an indicator of nutrient balances in the tea plant (*Camellia sinensis*) *Curr. Sci.* **23:** 78-79.

REPORT OF THE TECHNOLOGIST FOR 1959

E. L. Keegel

Staff Changes.—Mr J. B. E. Wickremasinghe, who was appointed Technical Assistant on 2nd February, resigned in June. His place was taken by Mr L. S. Weragoda on 1st August.

Advisory.—Seventy-seven visits were made to factories by the staff of the Technology Division. In most cases, lack of organization was the main defect. Faulty rolling equipment and incorrect operation of driers were other serious short-comings seen. Arising mostly from these visits, 662 samples were examined.

Clonal Manufacture.—Systematic manufacture of 47 blister-resistant clones was completed during the year. Eighteen eelworm-resistant clones, also grown at St Coombs, were tested for quality.

Besides these, 76 test manufactures were carried out on various estate clones. It is regretted that in some instances requests for quality tests had to be reluctantly refused because the clonal material to be examined was not of the required standard. Unless leaf is taken from bushes that have been in regular plucking for at least six months, a quality test may prove to be worthless. Leaf from bushes allowed to grow up for cuttings should therefore on no account be used for the estimation of potential inherent quality. At the same time conclusive evidence will not be obtained if a clone is tested only during a period favourable to the development of quality.

Pruning.—**(a) Tea at 4500′ elevation (St Coombs).**—The manufacturing properties of teas were studied from a field recovering from pruning at the beginning of the year. In the first few pluckings (5 to 6 months after pruning), the teas were considered to be fair and average for the time of the year. Even with such "young" leaf, the teas were affected by degree of wither and period of fermentation in the characteristic manner. When the leaf was only 7 months old (*i.e.* 7 months after pruning), the teas received very favourable reports, though inclined to be greenish. Manufactured during the flavoury season, they were considered as good as, if not better than, the average Dimbula teas made during this period.

As the weather changed, quality suffered the usual seasonal change. The leaf was then 9 months old. The teas continued to decline in quality with rush growth; modifications in manufacture failed to raise the standard.

No significant improvement was noticed with the arrival of the S.W. monsoon and till November, when the experiment was given up (leaf was

then approximately 16 months old), the teas had still little quality. They were also still greenish, but this was probably due to an inherent characteristic of the leaf from this particular field rather than to age from pruning.

From a study of tasters' reports over the whole period in conjunction with the general standard of teas produced in Dimbula district in 1959, it would appear that weather plays a more important part than age of leaf in the quality of a tea.

(b) Tea at 6000′ elevation (Nuwara Eliya district).—Comparison of two lots of leaf with a difference of $1\frac{1}{2}$ years in their ages from pruning showed no significant difference in quality. The colour and strength of the "younger" leaf were, however, very slightly preferable, so that the average valuation of these teas over the whole year was 6 cents higher than that from the "older" leaf. The respective ages were 42-54 months and 60-72 months from pruning.

Respiration Losses During Withering.—This investigation was started because of the interest shown in withering machines employing high temperatures, which might cause higher respiration losses and thus affect the out-turn. The results were inconclusive because of the difficulty of obtaining accurate figures for moisture contents of green and of withered leaf, for determining losses in dry matter.

It would be possible to derive a weight-loss figure by measuring oxygen consumption, but the matter was not pursued further because it was learnt that the withering drum, for instance, was to be used in the future at more normal temperatures.

Flavour.—Some of the conditions under which flavour is likely to be developed or destroyed were examined. The results were as follows.

(a) Period of firing.—Comparison of a 15-minute period with 21 minutes revealed very little difference, but the indications are that, under certain conditions of fermentation not yet definitely established, a shorter period of firing is advantageous for the conservation of flavour.

(b) Period of fermentation.—Flavour develops on the fermenting racks and takes approximately 2 hours to do so in the case of the early dhools, and less for the later dhools. The optimum period will of course depend on the temperature attained by the leaf in the rolling process.

(c) Withering.—The shorter the wither, the better is the flavour; and the results revealed that delaying a wither brought about a loss of flavour. Forcing a wither even by the use of heated air is preferable to extending the wither by natural means.

Freezing.—An important requirement of the present market is a tea with extra colour and strength, and these two characteristics are so highly valued that at certain times of the year they are even preferred to quality by some sections of the trade. It is a simple matter, of course, to satisfy these requirements by unconventional methods of rolling but the teas made by such methods would be unacceptable because of their poor appearance. It is therefore pointless to consider any new manufacturing process, however effective it may be, if it spoils the appearance of the tea. Freezing appeared to be one possible method of improving liquoring characteristics without detriment to appearance and quality.

Earlier unpublished work with small quantities of rolled leaf indicated that freezing could produce improvements in both colour and strength, presumably by more complete rupturing of the cells. On a larger scale the results have not been so encouraging, although temperatures as low as 0°F have been employed.

The following conclusions were reached:—

1. fermenting before freezing is preferable and, if fermenting after freezing is considered, a longer period is required for thawing and fermenting;
2. a certain amount of fermentation appears to occur in the freezer before the leaf gets down to freezing temperature, especially when the leaf is thickly spread;
3. thawing of frozen leaf, fermented before freezing, is unnecessary;
4. frozen leaf is always browner in appearance on firing than the unfrozen control.

Although some cells may be ruptured in the process of freezing, it is possible that freezing of rolled leaf does not improve fermentation to a marked extent because the juices and enzymes are not sufficiently mixed. The application of freezing in the fermentation process may therefore require a different technique and the question is under consideration.

Fermentation.—**(a) Relation to moisture content.**—Results of preliminary experiments indicate that the moisture content of the withered leaf is very important in governing fermentation. The softer the wither, the more rapid is the rate of fermentation. For instance, leaf from a commercial seedling field, which was withered to 52% moisture, fermented more than twice as fast as the same leaf with 44% moisture. It does not necessarily follow, however, that the characteristics responsible for the taste of good tea are developed at the same rate.

(b) Theaflavins.—Initial studies of this class of substance revealed that the theaflavin content reaches a maximum value during fermentation and then declines, the time to maximum depending on several factors such as the fermenting properties of the leaf, temperature of fermentation, and moisture content of the leaf. It was also observed that for any given period of fermentation, the softer the wither, the higher was the theaflavin content.

A good quality tea such as TRI 2024 was associated with a high theaflavin content. A wide field remains to be explored, and the results would help in the selection of clones for quality.

(c) Total colour.—The softer the wither, the more coloury is the liquor.

(d) Soluble matter.—The percentage total soluble matter decreased steadily with duration of fermentation. The harder the wither, the more soluble matter there was in the cup. It was difficult to correlate these findings with the taste of tea.

It may be pointed out that in all these investigations, minced leaf was used, because ordinary rolled leaf introduces many uncontrollable variables. Nevertheless there are indications that further work along these lines would lead to a better understanding of, and perhaps a better control of, the fermentation process.

Greenness of a Liquor.—Several experiments were conducted with a view to determining the factors contributory to the greenish character of a liquor, as distinct from the rawness associated with an underfermented tea. Apart from the inherent property of certain types of leaf, experimental evidence suggests that this puzzling feature in a tea liquor is very probably due to excessive rupturing of leaf, which releases some substance (not yet identified) which is readily extractable in a 5-minute brew.

Rolling.—**(a) The Keegel cone.**—There is a problem with this type of cone and, for that matter, all central roller fittings when used with the M and S (broad width) type of batten, a problem concerning the *surround* between the edge of the cone and terminal points of the battens. It is not perhaps realised that, since most of the rolling action takes place in the central region of a roller table, the type of arrangement near the cone is a most important deciding factor in the production of dhool. The Colombo Commercial Company, which markets the M & S battens, has now evolved a surround which is claimed to be suitable.

Just as important, or more so, is the position of the cone. Under no circumstances should the base be above *table* level. For battens of the M & S (broad width) type, the base of the cone should be absolutely level with the grooves of the battens. Elevation of the cone even by a fraction of an inch would cause undue breaking up of the leaf.

(b) New type of roller table.—A simplified rolling table is being developed, based on the findings that:

(1) a straight batten correctly designed is as efficient as any curved batten in current use;

(2) rolling action of any importance is confined to a certain area within a specifiable distance from the centre of a table.

Sifting.—The increasing demand for fannings grades in recent years has led to the use of various types of crushing machine, but these have tended to spoil the appearance of the teas. Some up-country factories, with a view to making smaller teas for the London market, employ 3/16″ cutter cells and have apparently had some success. The possibilities of using cutter cells much smaller in size were therefore examined. The sizes of the cells used for these experiments were 3/32″ and 4/32″.

In comparison with teas broken by pressure, the B.O.P. grade obtained from these small cutter cells was blacker. On the other hand, the corresponding fannings grade was browner—not an unexpected result, since a cutter does not differentiate between stalk and tea, whereas in a breaker under controlled pressure, only the lighter stalk finds its way into the fannings grade. In consequence, the liquor of the cut B.O.P. was preferable whilst the fannings grade had less colour and strength than that obtained from breaking. On balance, therefore, no advantage appears to be gained from using a cutter of very small size.

Other observations on the use of small cutter cells revealed that bloom was reduced and flake increased, and that liquoring properties were impaired. Although it was possible to increase the out-turn of the fannings grade by a considerable amount with only one cut, the poor appearance of the grade alone, coupled with increased formation of dust, rules out any possible application of very small cutter cells at present.

For the same reason, it is not at all advisable to use breakers for the sole purpose of reducing the size of a tea. Their function is described later, and the more knowledge we have on the subject the more firmly convinced we are that it always pays in the long run to have rational grade out-turns as the objective. Any improvement in the price of a fannings grade as a result of abnormal treatment is more often than not an illusory gain as it is generally obtained at the expense of the B.O.P. grade.

Stalk Extraction.—**(a) The Tarry Nipper Breaker.**—This machine works on the simple principle that in a mixture of tea and stalk, subjected to pressure, the removal of the stalk becomes easier because the tea is broken up to a smaller size whilst the stalk undergoes no major physical change. In view of the fact, however, that any such treatment has an adverse effect on the appearance and liquoring properties of tea, the greatest care is obviously needed in the first place in selecting the type of tea to be treated and secondly in determining the correct pressure.

Another important consideration is, of course, the type of stalk which it is proposed to extract. For the machine to work at its maximum efficiency, it is essential that the stalk should not be unduly broken. Since relatively light stalk may be reduced in size to about the same extent as tea, under pressure required to bring about an effective separation, it is recommended that the material be first winnowed before it is passed through the machine. If the 'tailings' are treated separately for say, conversion to broken mixed fannings, it would be possible in this way to reduce to a minimum the amount of stalk that finds its way into the tea.

Naturally, no hard and fast rule can be given as to thickness of spread, degree of pressure, and number of treatments necessary to remove the maximum amount of stalk without at the same time spoiling the tea. This is a matter for trial and experience, but for the best results it is recommended that:—

(1) the thinnest possible spread should be adopted;
(2) excessive pressure should not be used;
(3) the tea should not be successively treated without the removal of the smaller particles after each operation.

If these precautions are taken, the Tarry Nipper Breaker would prove to be quite an useful part of tea-factory equipment. But since there is no doubt at all that it has a definite greying and flaking effect, it has only a limited application. It should not be used in place of a cutter with the object of reducing the size of the larger particles found in sifted tea, except perhaps in the case of the last dhool and the big bulk. Neither can it be recommended for increasing the B.O.P.F. or Dust No. 1 grades. Its useful functions appear to be in;

(1) improving the appearince of the off-grades;
(2) converting broken mixed to fannings and dusts; and
(3) removing stalk from the last dhool and big-bulk simultaneously with their conversion to B.P. and other off-grades. If O.P. is required, this grade should first be taken out.

Complete elimination of stalk is not possible, but since the process takes a considerably shorter time than hand picking, the Tarry Nipper Breaker does serve a useful purpose. It is difficult to say to what extent a saving in picking costs results from its use.

(b) The Electro-static Stalk Extractor.—This Japanese machine, which was first introduced into the Island about 4 years ago, is now recognized as an integral item of factory machinery. Some misconceptions still exist about this machine, however, one being that teas subject to an electro-static charge do not keep. Experiments carried out at St Coombs have conclusively proved that keeping properties are not affected.

Another criticism levelled at the machine is that liquoring properties are impaired. Undoubtedly, in the process of cleaning a tea whether by electro-static methods or any other means, a small loss in colour and strength occurs because of the removal of small particles, fluff, and light leaf. The cleaner a tea is made, the greater is the effect. It is obvious, therefore, that to get the best results from an electro-static separator, too much should not be removed from the tea to be treated. Just as much care is needed when using a stalk-extractor as is normally exercised in winnowing a tea. Comparison of teas winnowed in the normal way with teas treated in the Japanese stalk extractor at St Coombs, where the percentage of rejected material was the same in each case, showed no difference.

Yet another belief is that the use of the machine causes greying of the tea. There is no evidence to suggest that such an effect is produced.

The mechanism of stalk extraction by electro-static methods was studied in some detail and all the evidence available indicates that the factor mainly responsible for the separation of stalk is density rather than the minute differences in moisture between stalk and tea particles. Experiments revealed a definite decrease in the percentage by weight of the stalky fraction with increase of moisture, and this could be explained on the basis of increased weight of the stalk and fibre due to the absorbed moisture. This is probably the reason why more satisfactory results are obtained with freshly fired teas than with teas that have been stored for some time.

Packing.—**(a) Chests.**—On behalf of the Forest Department, storage tests were carried out on 8 boxes of 8 different local species of timber to examine their suitability for the packing of tea.

(b) Card-board packs.—Further to the work carried out on corrugated packages, sample cases laminated with 0.025 m.m. gauge were tested for their moisture proof properties and found to be satisfactory. They are however unacceptable to the trade, the chief objections being difficulty of sampling teas, lack of re-sale value to ultimate buyer, easier pilferage, and the likelihood of teas packed in such containers being sold at a discount.

(c) Plastic linings.—Various types of plastic-coated papers were experimented with and it was found that the degree of impermeability to moisture varied with the thickness of the film. However promising some of these may be, their present high costs and lack of second-hand value do not encourage further investigations of the practical possibilities of plastic material for the packing of tea.

Taint Trials.—The following compounds were tested:—

Kelthane	...	no taint
Tedion	...	inconclusive
Ziram	...	inconclusive
Mitex 13	...	oily taint

Dieldrin	...	no taint
D.D.T.	...	no taint
F. 26 (Photo-Cinex)	...	no taint
D. 36 (Photo-Cinex)	...	inconclusive

Preservation of Tea.—(*a*) According to Monsanto Chemicals Ltd. of London, tea may be preserved against mould growth by packing it in a material coated or impregnated with benzoic acid.

Tests showed that the direct incorporation of the product into tea exposed to air was effective in preventing the formation of moulds. In teas packeted in ordinary brown paper and stored for over two months, no mould growth was noticed even in the control, despite the fact that the moisture content of the teas had risen to 11%. The packets treated with the preservative, when opened, gave out a strong odour and there was a suspicion of a taint in the brewed liquors.

It may therefore be concluded that, with teas as now packed and distributed all over the world, the addition of a preservative to check mould growth is pointless. However, a preservative would serve an useful purpose in the case of teas directly exposed to humid conditions, provided it does not impart a taint.

(*b*) A method claimed to preserve aroma and flavour in tea is the use of glycerol in combination with water or with the addition of citric or other acids and expressed juices from a tea roller. Applied on tea, glycerol in solution caused mouldy growth after some time and the projected observations on aroma and flavour had to be abandoned.

Publications.—

Mahadeva, B., Amarasuriya, F., Coultas, W. H. W., Sanders, N. M., Keegel, E. L., & Kehl, F. H. Report on the visit to the tea producing areas in Georgia, U.S.S.R., by a delegation from the Tea Research Institute of Ceylon. *Tea Quart.* **30:** 5–18.

Keegel, E. L. A new type of infra-red moisture tester—The Ase moisture balance. *Tea Quart.* **30:** 46–47.

Kehl, F. H. & Keegel, E. L. Report on visits to North-East and South India. *Tea Quart.* **30:** 71–85.

Keegel, E. L. Tea made from clones. *Tea Quart.* **30:** 134–141.

Keegel, E. L. Comments on Mr Hutton's notes on drum withering. *Tea Quart.* **30:** 155–156.

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NOTICES

General.—The laboratories of the Institute are situated at St Coombs Estate, Talawakele, and letters and enquiries should be addressed to the Director, Tea Research Institute, Talawakele. Telegraphic address: Research, Talawakele, Telephone: Talawakele 44 (Private Exchange).

It is particularly requested that letters should not be addressed to officers by name. Specimens and other consignments sent by rail should be forwarded to Talawakele Station, c/o Messrs M. Y. Hemachandra Co., Ltd., Forwarding Agents. *Carriage should be pre-paid.*

Low-country estates should address their correspondence and enquiries to the Low-Country Adviser, T.R.I., "Kalindi," Riverside Road, Ratnapura.

Visitors' Days.—The *second* and *last* Wednesdays in each month have been set aside for Visitors' Days at St Coombs Estate and also at the T.R.I. Sub-Station, Gonakelle Estate, Passara, when it is hoped that those interested will visit the station.

Guest House.—The house formerly used for guests is now an officer's residence and it is regretted that, for the time being, no Guest House facilities are available. Those visiting the Institute or the Estate on business, who are unable to arrange accommodation in the neighbourhood, should seek the help of the Director.

Publications.—The Tea Quarterly, Bulletins (New Series), Pamphlets, and Annual Reports, published by the Tea Research Institute will be sent free of charge to Superintendents of Ceylon tea estates over ten acres in extent and to estate agencies dealing with Ceylon tea, if they register their names with the Director, Tea Research Institute of Ceylon, St Coombs, Talawakele.

Other persons can obtain the publications of the Institute on application to the Director, the post-free subscription being fifteen rupees per annum for persons resident in Ceylon or India and £1–5–0 for those resident elsewhere. Single numbers of *The Tea Quarterly* can be obtained for Rs. 2.50 or 4*s*. Indian cheques should have four annas added to cover commission.

The Tea Research Institute of Ceylon

Board of Control at December 31st 1959

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Secretary:—

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Representing the Small Holders:—

Mr D. E. Hettiarachchi, J.P., U.M.
Senator Reginald Perera

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Vacant

Ex-Officio Members:—

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The Director of Agriculture (Dr M. F. Chandraratna, M.B.E.)
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Chairman, Planters' Association of Ceylon.
Mr G. I. [illegible]anville
Chairman, Agency Section, Planters' Association of Ceylon.
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Chairman, Low-Country Products Association.
The Tea Controller (Mr B. Mahadeva, C.C.S.)
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